PUBLISHED IN PARTS EVERY ALTERNATE MONTH.

PART IV. *January*, 1840.

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THE CYCLOPÆDIA OF PRACTICAL SURGERY,

EMBRACING A COMPLETE VIEW OF

ALL THE DEPARTMENTS IN OPERATIVE MEDICINE.

EDITED BY

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LONDON:
SHERWOOD, GILBERT, & PIPER,
PATERNOSTER-ROW.

[PRICE FIVE SHILLINGS.]

GILBERT & RIVINGTON, PRINTERS, LONDON.

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portion between the length of the contracted muscles, and the function they should perform is increased; and the deformity of the limb is usually augmented, unless well applied mechanical means have kept it stationary. Hence another cause, cæteris paribus, why there is more actual elongation to be accomplished in children than in adults.

All these circumstances considered, in relation to the particular case of partial ankylosis of the knee, which I have begun to detail in this paper, combined with the knowledge of the fact that the best mechanical skill had been for twelve months completely frustrated by the unyielding state of the muscles, I concluded that nought would overcome their resistance but their division with the scalpel.

What share had the evidently contracted gastrocnemii in maintaining the ankylosis of the knee, and what was the nature of their contraction, were however the next queries to be solved. The wasted muscles of the calf formed a strong broad band, extending from behind the lower end of the femur to the posterior extremity of the os calcis, which points of origin and insertion were approximated, accompanied, therefore, with the flexion of the knee and so-called extension of the foot upon the leg, so that the heel was constantly drawn upwards. Pressure with the hand against the point of the foot served to bend the ankle joint somewhat, but this tended again to increase the flexion of the knee; nevertheless the gastrocnemii were more elastic, the attempts to elongate them were not met by a resistance so stubborn as that offered by the flexors of the knee, although whatever little was gained upon them by a few minutes' pressure, was lost again when the hand was removed from the point of the foot. The explanation of the cause why there should have existed so great a difference in the nature of the contraction of the gastrocnemii, and that of the flexors of the thigh, will be understood by reflecting upon this case in connection with that which I have stated to be a second not uncommon cause of inextensible muscular shortening in children. Gradual contraction, during a long-continued state of rest, was the primary cause in both sets of muscles, tending to organic inextensible shortening: but there was the remarkable difference, that the thigh bone had grown considerably during the four years the disease had lasted; it had shot out to its proper length, thus greatly increasing the relative shortening of the flexors of the thigh, whereas, as I have stated, the tibia and fibula were atrophied, not only in their diameter, but more particularly as regards their length; they were at least three inches shorter than the corresponding bones of the opposite limb, so that although the same primary cause of the structural shortening of the gastrocnemii had existed, the bones of the leg having ceased to grow during the continuance of the disease in the knee, their contraction was much less rigid than that of the biceps femoris, semimembranosus, &c. I was of opinion, therefore, that there would be no necessity for the division of the tendo Achillis, but that on the contrary the gastrocnemii might be gradually elongated by an appropriate instrument, so as to bend the patient's ankle, and enable her to put the heel to the ground, removing at the same time, whatever bending of the knee depended upon their contraction.

The danger of reproducing the disease of the articulation, by performing an operation in its vicinity, and by a comparatively rapid extension of the limb disturbing the quiet state of the ligaments, was next to be considered. It did not appear to me, however, that any danger of this kind existed, as the disease had completely subsided two years before, and the patient's general health, which was good, though rather delicate, had, according to the report of the gentlemen who had attended the patient, so much improved since that time, and particularly when compared with her evidently strumous state, when the disease commenced. To proceed very cautiously however, I determined to carry on the necessary extension after the operation, as slowly as possible; and should the least indication of an untoward result occur,—any symptoms threatening a renewal of the knee-joint disease—I resolved to suspend the extension, or lay it aside altogether. The only remaining question was, whether, if the operation proved successful and the knee were straightened, the patient would have a limb (shortened and wasted as were the bones and muscles of the leg), sufficiently useful to repay her for the pain and risk of the proceeding. The most desirable termination possible of this case would be, that the patient should obtain a bent ankle, a straight knee, and the power of moving them in either direction, flexion and extension. That she would obtain the first, there could be little doubt; as to the second, it was most probable. She would also obtain the power of moving the ankle naturally; but as to usefully moving the knee-joint by voluntary muscular efforts, the prospect was very distant, as not only the inadequate condition of the flexors of the thigh as respects power had to be considered, but it was impossible to decide upon the competency of the articular surface of the three bones of the knee to perform their natural office. The really important point was to straighten the knee, which, if accomplished, supposing it even to remain fixed in the straight position, would alone amply requite a patient and parent for all the pains and troubles of an operation succeeded by mechanical treatment. Upon that judgment alone, I recommended the operation, considering, that although the patient would for some time require to use a stick, and constantly a cork-raised shoe as some substitute for the atrophied bones of the leg, a straight knee and leg, with the ankle restored to its natural motion, were a preferable alternative, either to the necessity of getting about upon two crutches with a knee bent to an angle more acute than a right angle, or to an amputation, which had been more than once proposed as the ultimatum. If the limb were straightened, and the knee was immovable in its newly acquired state, there would be no difficulty in bending it by the same mechanical means which had straightened it, if that were thought desirable. And again, if before the limb became thoroughly straightened, much inconvenience and pain, or any other disagreeable symptoms were to occur, so as to require the discontinuance of the extension, the question arose, whether, considering the partial luxation of the head of the tibia backwards, the patient would not walk with greater comfort and less apparent lameness, with the knee slightly bent, than with it absolutely straight.

The operation was rapidly completed in the following manner, observing the same precautions as in dividing tendons for the cure of congenital or acquired contraction of the ankle, called club-foot, &c., namely, to divide the tendons, with no more disturbance of contiguous parts or breach of surface, than may be absolutely necessary to procure immediate union of the wound, if possible, and not to exert any extension of the joint until adhesion have taken place; as, by following an opposite course, through an useless anxiety of seeing whether the limb can be straightened, inflammation and suppuration might be induced and endanger success. The propriety of making extension immediately after an operation is negatived by the results derived from experience, viz. that divided tendons, like fractured bones, do not unite *firmly* until a considerable time has elapsed; by obtaining an immediate union of the skin, (which has followed without one exception, in more than sixty cases in which I have treated contractions of the ankle by division of the tendo Achillis, &c.,) the divided tendon is reduced to the state of a simple rupture, which, compared with a suppurating wound of tendon, is analogous to the difference between simple and compound fracture of a bone.

The patient was placed upon her face and abdomen upon a sofa, the point of the knee resting upon a pillow; one assistant supported the thigh, whilst another, with his hand upon the back of an ankle, used the leg as a long lever to act upon the knee-joint, by which the tendons were kept perfectly tense.

The knife used by me for the division of the three flexor tendons of the thigh, in the case I am relating, was a very narrow convex-edged scalpel, the point of which I introduced through the integument at the back of the articulation, to the outside of the tendons of the semi-membranosus and semi-tendinosus muscles, with one of its flat surfaces directed towards those tendons. The point of the knife was carefully glided beneath them, its cutting edge turned towards, and pressed against them, by which they were immediately severed, owing to their being held well upon the stretch. The knife being withdrawn, the integument was stretched by the fingers of my left hand, a little outwards, so that the puncture by which the semi-membranosus and semi-tendinosus tendons had been divided, was brought directly above or somewhat to the outside of the biceps tendon, which was now felt to be the only tendon undivided, whilst with my right hand, I introduced beneath the biceps, through the same puncture of the skin, a small curved bistoury, having a concave cutting edge, by which the tendon was instantly divided. A small quantity of arterial blood flowed, which ceased by slight compression with lint. Adhesive plaister and bandage were applied. The patient was made comfortable, and left quiet upon the sofa; she complained of pain in the divided part, and some numbness of the skin behind the joint, as if some filament from the sciatic had been injured. She ceased to complain of these a quarter of an hour after taking ten minims tr. opii. She had no fever or constitutional disturbance; the wound united perfectly by adhesion; so that on the third day after the operation, the apparatus for gradually extending the joint was applied. I had the satisfaction of seeing the limb rendered daily more and more straight, without any pain or sense of resistance being felt in the divided part, or in the back of the thigh; her chief complaints having been that of irksomeness, from having the limb constantly more or less compressed by the straps of the apparatus, and occasionally pain in the front of the articulation, whenever the extending screws of the apparatus were turned. At the expiration of two months the knee was becoming nearly straight, and I considered the time arrived for attending to the ankle, the extension of which in a patient of less excitable disposition would have been carried on simultaneously with that of the knee. The contrivance for effecting that, was set into operation; but my patient's health not being improved by the necessity of keeping her so long within doors, owing to the severity of the late winter, and neuralgic pains in the face to which she had been subject coming on, induced me not to subject her delicate frame to daily trial, but rather to advance with the extension by the most insensible degrees. This determination was arrived at by me the more willingly, as an elder sister had died of tubercular phthisis, and argument might not stem the prejudices of affection, should any serious deterioration of her health have ensued; for in such a case, the operation would be impugned as a cause of that or perhaps of any subsequent misfortune, whereas, in truth, the cure of a patient's limb, by restoring the individual to hilarity, air, and exercise, would be one of the most certain impediments to a strumous or consumptive tendency. Not a single unpleasant event, however, has occurred during the treatment, beyond two slight abrasions of the cuticle; the ankle is restored to its natural state, the knee is very nearly straight, and the patient can voluntarily move the joint, flexing and extending it sufficiently to show that the divided tendons have firmly re-united, and that the long-lost action of the muscles is restored. With a sufficient thickness of cork beneath the sole, to compensate for the shortness of the tibia, she is able, six months after the operation, and after nearly five years' confinement to the sofa, to help herself about with a stick, and as the muscles of both limbs, weakened by long inactivity, acquire power, she will doubtless lay the former aside, and walk with considerable ease and freedom. The time occupied by the treatment of this case, short as it is, compared with the results obtained, might, under ordinarily favourable circumstances, as in an hospital, or with a patient whose health and age would enable the surgeon to advance uninterruptedly with the treatment, be considerably shortened, reduced indeed, with safety and propriety, to six or eight weeks.

In all such cases, treated by operation, the adjuvant treatment of warm and steam baths, liniments, frictions, and manipulations, should not be omitted, particularly after the extension by instruments has been accomplished, in order to obtain freedom of motion, and prevent any tendency to recontraction of the restored limb. I have detailed the nature and progress of this case, not merely on account of its individual worth, but because it illustrates my opinions relative to partial ankylosis, and some of its proximate causes, and because, beyond the brief notice of M. Duval having done the same operation, (Lancet, No. 15, Vol. I. 1837—38,) as it had also previously been done several times with success by Stromeyer of Hanover, and once by Dieffenbach of Berlin, I am not aware that any thing of the kind has been published in our own or in the French and German languages.

Of the ankyloses depending entirely or partly upon the muscles, I have in this place to consider the treatment of those cases only which come under the first of the four sections, in which I have included all the varieties of partial ankylosis which have presented themselves to me; namely, those cases which arise from sloughing, or from adhesions of muscles to one another and to the bones, as those (*partial ankyloses*) which come under the second and third sections, i. e. depend primarily upon *spasmodic* contraction, or upon *organic* contraction through *paralysis* of antagonists, will be more appropriately considered in the articles Contracture, Club-foot, and Paralysis, to which the reader is referred.

Where a considerable extent of muscle has been lost by sloughing, or rendered unserviceable by adhesion to the fasciæ and particularly to the bones, any method which might enable us to restore to the ankylosed limb its natural form and motion, would of course be unavailable in the restoration of the integrity of the tissue, or its function; but where numerous muscles, as in the thigh or leg, concur in the motion of an articulation in a given direction, the major part of one or more muscles may not only have been lost, or owing to adhesions rendered useless as regards their particular office, but they may also interfere with the functions of all the neighbouring muscles, by forming tight cords or bridles, thus limiting the motion and inducing incomplete ankylosis of the adjacent joint, or indeed joints, if the injured muscle passes over two articulations, as the gastrocnemius for instance does. In these cases much may be done by extension with appropriate apparatus, but a cure can seldom be attained by mechanical means only, unless the morbid alteration of the form of the joint be trifling, or the affected muscles or the bands of adhesions be small, and capable of being easily elongated by stretching: even in the smaller joints of the body, partial ankylosis from sloughing or adhesion of tendons and muscles, is seldom cured by merely mechanical means; still less successful are we in overcoming the deformity by such means, when one of the larger joints, as the ankle for example, is affected. In two cases of partial ankylosis of the ankle-joint in the extended position, the result of abscesses involving the gastrocnemii muscles, with caries of the bones in the one case, and extensive necrosis in the other, I have been obliged to have recourse to division of the tendo Achillis, which was followed by perfect and rapid success. These cases are related at length in the Lancet, (Vol. II. 1837—38, p. 290, 338,) an abstract of which I give here.

July 27, 1837.—Miss ———, ætat. 24, informs me that some disease of the right leg, supposed at first to have been rheumatic inflammation, commenced nearly nine years ago, and continued four years, during which period she had numerous abscesses in different parts of the back and outside of the leg, from several of which large pieces of bone were removed. When the wounds had entirely healed, and she had recovered her strength, she found herself unable to touch the ground with more than the front of the foot, the ankle-joint being almost immovably fixed in the straight position, the heel drawn up from the ground between two and three inches, and her walking rendered consequently very difficult, which has continued so, as she says the great fatigue and perspiration after going half a mile are very distressing to her. The gentleman who had attended her, placed her under the care of a mechanist of repute, who undertook, by appropriate apparatus, to overcome the contraction of the calf and force the toe gradually upward, and the heel down to the ground. This plan has been persevered in by the almost daily attendance of the mechanist ever since, up to the present time, without any other benefit than that of having prevented the contraction from increasing.

August 1.—I divided the tendo Achillis, using a very narrow straight bistoury: The patient being seated in a chair, one assistant supported the knee, whilst another, grasping and drawing downwards the patient's heel with his left hand, and pressing upwards the toes and front of the foot with his right, rendered the tendon to be divided as tense as possible. After feeling with my left thumb and forefinger the outline of the tendo Achillis, in this case partially connected to the surrounding parts by adhesions, I passed the small bistoury through the skin, one or two fingers' breadth above the malleolus internus, with one of its sides turned towards the tendon and immediately above it, (the patient sitting), the other directed towards the deeper muscles and the tibial vessels and nerves; and as soon as I knew that the point of the knife was passed beyond the external edge of the tendon, and had nearly reached the skin of the opposite side, I turned the knife so as to bring its cutting edge to press against the tendon, which was cut at one stroke, on withdrawing the knife. The recoil of the severed ends of the tendon was distinctly felt and heard. The puncture was dressed with a strip of adhesive plaister and bandage, and the limb as usual laid in its deformed position upon a common pasteboard splint.

Second day after the operation.—The dressing was removed, and the puncture found to have united by adhesion. On examining the limb I felt a small string, or bridle, remaining undivided at the part where I had cut the tendon. It may have been the plantaris tendon, as it was upon the inside of the tendo Achillis, or a strip of fascia, or a small band of old adhesions. I divided it by a very minute puncture, and placed the limb, after dressing it, upon Stromeyer's foot-board, without exercising any extension.

Fourth day.—The cord of the apparatus tightened, for the first time, so as to keep a little tension upon the joint.

Seventh day.—The extension has been carried on slowly, and without inconvenience to the patient, except from the pressure of the apparatus against one of the corns which cover that part of the sole upon which she trod formerly. A friend of the patient undertook this morning to remove the projecting part of the corn which occasioned the pain, in doing which he unfortunately wounded the cutis; this little accident has occurred most inopportunely, as the tenderness which may result therefrom will prevent me from persevering with the use of the apparatus to rectify the position of the foot until it has perfectly healed.

Tenth day.—The apparatus has continued to be worn, but the anticipated inflammation around the corn has required the application of poultices, and prevented any progress being made. The pain in the sole is subsiding, and the little wound made through cutting the corn is healed; the extension, therefore, is now to be pursued.

Eleventh day.—Patient has complained much of pain in that part of the foot covered with the corns; so much, indeed, did she suffer during the night, that being summoned to her, I was obliged to loosen the apparatus, although it was by no means tightly applied. The slight, though constant pressure, had sufficed to re-excite inflammation of the skin around the corns. In order that the pressure of the foot-board may hereafter be distributed equally over the entire sole, I have placed between it and the foot-board a temporary air cushion, which I have prepared by introducing one portion of the gut of a bullock within a second portion of the same, tying the double intestine firmly at one end, then inflating it and securing it at the other. This contrivance was no sooner applied than she expressed herself totally relieved from soreness and pain; she could even bear immediately a much greater pressure than I thought necessary for the gradual forcing upward of the toes; in short, she was rendered more comfortable with the foot-board on than without it, as the elastic uniform pressure against the entire sole, eased her at once from the burning pain of the inflamed skin around the corns.

Twelfth day.—My patient is delighted with the progress she is making, as the heel has visibly descended, and I, that my experiment with the air cushion has succeeded so perfectly. To-day I have substituted for the inflated intestine a properly made caoutchouc air cushion. I have directed her to walk about the room, so as to assist the thrusting down of the heel, by throwing the weight of the body upon her foot. All pain in the corns is gone, although she is beginning to complain of pain in the situation of the ligaments of the joint. Spirit lotion to be applied constantly to the ankle.

Sixteenth day.—The foot-board has been very well borne since last report; I have removed it to day, and allowed her to walk across her apartment, the entire sole and heel of the foot touching the ground, without any apparatus; I have, however, re-applied it, intending to bend the ankle to such an extent that the foot may form an angle with the leg as acute as natural.

Twenty-second day.—The foot is now bent almost as much as is necessary to ensure perfect walking by-and-by. I have discontinued the foot-board, and have applied instead a lighter instrument of my own, which combines the perpendicular elastic springs of the Scarpa shoe, for the cure of club-foot, with a certainty of bending the joint to the natural extent, by means of a screw, acting against the spring as a lever; she can, therefore, walk about with facility and ease. All the inconvenience she has now is from tenderness of the ligaments of the joint which have been stretched.

Six weeks after the operation she walked about in a common shoe, the ankle joint possessing the natural extent of motion; at the end of two months, when all œdematous swelling had subsided, the union of the tendo Achillis could be felt to be perfect, and by means of the gastrocnemii, tib. post., &c., she could straighten the foot upon the leg, and contract freely the anterior tibial muscle, and raise the foot ; the peronei had also recovered their power. She suffered occasionally, during the very severe cold weather, from pain in the ankle-joint, which for a short time caused her to walk rather lamely. Her gait continued to improve until four months after the operation, when she was walking about as well as a person who had never had any lameness.

The second case is still more interesting, as the ankylosed, almost immovably rigid state of the ankle-joint had existed twenty years, and although the treatment was more embarrassing than the preceding, through the greater destruction of soft and hard parts, and the consequent numerous adhesions in all directions, its complete success shows how valuable an improvement in the treatment of some cases of partial ankylosis we possess in the division of tendons.

Sept. 4, 1837.—Miss ——, aged twenty-seven, informs me that when about seven years of age, she was attacked with some disease in her right leg, accompanied by numerous abscesses, ulcerations, fistulæ, &c., the last of which closed twelve years ago. During the continuance of this protracted disease she was necessarily prevented from walking, so that on its subsiding it was found that the extended state which the foot assumes, owing to the superior power of the gastrocnemii, and other muscles on the back of the leg, overbalancing the anterior muscles when the influence of volition is not exerted,—a state in which the foot had remained so many years,—combined with the gradual contraction of the numerous cicatrices, had produced a permanent elevation of the heel, from the ground to the utmost possible extent. At the present time she walks upon the extreme point of the sole of the foot, corresponding to the metatarso-digital articulations, where there exists the usual painful corn, which in such feet covers the cutis, wherever it is subjected to undue friction or pressure ; the heel is drawn upwards by the contracted muscles of the calf as much as five inches, which distance from the earth it retains even when the entire weight of the body is thrown upon the affected limb, or the patient strains to force it down ; so rigid, indeed, is the contraction, that no efforts which I can exercise to force up the toes, procure the least alteration in the form of the foot. There is no deformity of the foot itself beyond the fixed state of so-called extension, and a somewhat greater convexity of the arch of the foot than natural. All the muscles of the affected thigh and front of the leg are weaker than those of the opposite side ; those of the back and outside of the leg are bound down to the bones by ten or a dozen large indented cicatrices, some of them more than three inches in length. She can produce no voluntary motion by any action of the anterior muscles, through their being kept continually upon the stretch, nor by the posterior muscles, from some of them being firmly bound down in various parts to the bones, and from the remainder being already contracted to their fullest extent. The entire extremity, owing to the fixed straight position of the foot, is rendered longer than that of the opposite side, although the tibia and fibula, being about an inch shorter, by comparison, than they should be, diminish by that much what the excess in length of the extremity would otherwise have amounted to, and, together with the studious efforts of this young lady to conceal her lameness, by walking leisurely, and as much as possible upon the toes of the sound leg, renders her deformity less evident than it otherwise would be. She tells me, however, that she is incapacitated from standing long, walking far, or upon a sloping or uneven pavement, without considerable pain and fatigue. That no true ankylosis of the joint exists, is known by the lateral motion which can be given to the astragalus and tarsus, by moving the toes alternately inwards and outwards.

The indications of cure were to divide the tendo Achillis, as in similar contractions from other causes, and by gradual stretching by the appropriate apparatus, to obtain, if possible, the full natural extent of motion of the ankle-joint. But there were difficulties in the way of an operation—the lowest cicatrix uniting skin, bones, and tendo Achillis, approached so near to the insertion of the latter into the os calcis,—within an inch of it,—and the distance between the anterior surface of the tendon and the back of the ankle-joint, which is occupied in a healthy limb, by yielding cellular tissue, appeared from the thickening and induration around the tendon, to be filled up by so dense a mass of organised lymph, that there remained no part of the tendon, at which its section could be very conveniently accomplished. There was the necessity of keeping sufficiently far from the bursa, at the insertion of the tendo Achillis upon the one hand, and the objection of traversing old cicatrices with the knife on the other. As, however, I was convinced that with the division of the large inelastic tendo Achillis, and as much of the subjacent indurated cellular tissue as I could, with safety to the tibial vessels and nerve, reach (unless that which might be left undivided were completely fibro-cartilaginous), much more than half of the obstacles to bending the joint would be overcome, I did not hesitate to undertake the treatment of the case, upon the same principles as those which guide me in the uncomplicated congenital or non-congenital club-foot.

Sept. 7.—Divided the tendo Achillis, using a small straight French bistoury. I passed the knife into the inside of the limb, opposite to the part where the tendon was least engaged by the adhesions, as far from the anterior surface of the tendon as was compatible with the safety of the posterior tibial vessels, &c., one side of the knife being directed towards the latter. The cutting edge was then directed outwards, against the tendon, the point being made to describe a quarter or third of a circle, of which the centre was that part of the blade in contact with the external punctures. By this cutting outwards, and circular motion of the point of the knife, nearly all fibro-cartilaginous adhesions, (for they were felt by me to be gristly whilst cutting them,) between the edge of the knife and the skin, as well as the tendo Achillis, were divided, as in the method I usually adopt for cutting the latter only, without any puncture being made in the opposite side of the leg. After the withdrawal of the knife two small remaining portions of fascia, or bands of adhesion, were felt through the integuments to be still unsevered; they were cut by reintroducing the bistoury. There was but one wound, a quarter of an inch in length, which healed the second day by first intention.

On the sixth day Stromeyer's foot-board, with an air-cushion beneath the sole of the foot, was applied, without attempting much extension of the remaining resisting tissues of the back of the leg, viz. the tibialis posticus, flexor muscles, and the ligaments of the joint, as I judged it prudent to proceed more gradually than after an ordinary section of the tendo Achillis, and allow the lymph effused in the track of the knife, through the tendon and through the old cicatrices, to become more fully organised, that there might be no chance of exciting any degeneration of the reparatory process, or inflammation, notwithstanding the part was completely healed.

After a few days, the cord of the apparatus was slowly tightened. The patient complained of having restless nights, took a few doses of tinct. opii unavailingly; did not refer the pain she endured from the apparatus to the situation of the lig. deltoideum and fibulare posticum, (to the former of which, in particular cases, after the operation for club-foot, patients point as the part where they feel that stretching is going on,) but complained chiefly of an acute pain at the back of the fibula, two inches above the malleole. At the eighth day of carrying on the extension, I found, to my disappointment, that the foot was nearly in the same position as before the operation, the heel having descended only a very little; I was certain, therefore, that some unusual impediment to the bending of the ankle existed; and as there was a cicatrix adherent to the bone, and a little inflamed, as if it had been on the stretch, and at the place where she complained of pain and stretching, close to the situation of the tendons of the peronei muscles, I suspected that the latter might be interested in the cicatrix, and adherent to the fibula, although before the operation I believed them to be free; I resolved, therefore, that if a subsequent examination confirmed me in my suspicion, I would divide those tendons lower down than the cicatrix. The bandages and apparatus were removed altogether; the spirit lotion prescribed to be applied constantly to the ankle, and a dose of laxative medicine to be taken, to accelerate the removal of œdema of the parts which obstructed an accurate examination.

On the eighteenth day after the division of the tendo Achillis, when all swelling had subsided, I was able to satisfy myself of the state of things. There was no adhesion of the peronei tendons at the cicatrix, for when the ankle-joint was moved as far as the deformity admitted, I could feel that they were rendered alternately tense and lax, both below and *above* the cicatrix. The latter was still slightly red and puffy; when I attempted to press the toes upwards she had pain there, ranging from the cicatrix to the posterior extremity of the os calcis, and by careful manipulation I discovered what I supposed to be a firm band, passing from the os calcis, or from the inferior portion of the divided tendo Achillis to this lowest cicatrix of the fibula. Pressure in the direction of this band gave pain, as did also, upon repeated trials, the forcing upwards of the toes. I determined consequently, to divide it between the cicatrix and its connection with the lower part of the tendon, which was done after the manner of dividing a tendo Achillis, except that I introduced the knife upon the outside of the limb. The wound where the knife entered healed the second day, but a minute puncture made by the curved point of the knife, in the posterior median line, was more slow to cicatrize. Stromeyer's foot-board was now immediately re-applied, and the same degree of extension which produced before much pain and uneasiness, was borne after this second operation, with comparative ease, so that she was able to walk about; the heel gradually descended, and on October 9th, fourteen days after the second operation, she was able to put the heel and entire sole to the ground, which she had not done for twenty years. A lighter modification of the apparatus was worn three weeks longer, to support the joint whilst walking about, and also (although the foot had now acquired, in the eye of a cursory observer, a perfectly natural form,) to endeavour, if possible, to bend the ankle beyond a right angle with the leg, and obtain the full extent of natural motion. The wearing of this latter instrument occasioned not the slightest uneasiness; it was rather a source of ease to her, for when the foot was allowed to hang loose, owing to the anterior muscles of the leg having been so many years elongated, and therefore unable to hold the foot in the bent state, she, as all patients for a short time after the operation do, felt pain from motion of the recently disturbed parts about the joint, ligaments, &c.

Nov. 5.—All apparatus laid aside, and patient is now walking about with a common shoe on; her gait is like that of a person just recovered from a sprained ankle, or broken leg, putting the foot cautiously to the ground, and turning the toes outwards, in which position the ankle is bent as little as possible, to avoid motion of the yet tender ligaments of the joint. Her only complaint is, that her leg feels so much shorter than it was formerly, or than the other now is, the bones of the leg, as was stated at the commencement of this report, being nearly an inch shorter than those of the opposite extremity; but the impression whilst walking is, that the limb is at least three or four inches too short, which arises from a false sensation, depending upon the former greatly elongated state of it. Her spinal column and pelvis, and the vertebral and pelvic muscles, had accommodated themselves to the unnatural length of the deformed limb, and therefore as the ankle-joint is restored to its proper action, and the limb shortened as much as the heel was formerly elevated from the ground (five inches), it is not surprising that the change to her feelings should be so remarkable, and the nature of it so deceptive. A bystander would remark, that even now that the foot is cured, and she has been walking about upon the heel three weeks, the shoulder of the affected side is thrown higher than the other, so slowly do the pelvis and vertebral column right themselves after having been obliged to assume an unnatural position so many years.

At the present time, six months after the operation, she is able to walk and dance almost as well as if she had never been the subject of partial ankylosis.

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ANKYLOTOME, the same derivative, and *τέμνειν*, 'to cut.' A general name for curved knives of every kind. According to Scultetus, it was used to designate a curved knife formerly in use for dividing the frænum of the tongue.

ANTEVERSION, UTERUS OF, from *ante*, forwards, and *vertere*, to turn. *Anteversio*, Lat. A displacement of the uterus, in which it turns upon its short axis, the fundus of the organ being carried forwards and downwards towards the pubis; the orifice backwards and upwards towards the curvature of the sacrum. In this position, the large diameter of the organ is horizontal. (See Uterus).

ANTHRACOSIS, Lat.; *ἀνθράκωσις*, Gr.; *anthracose, charbon des paupières*, Fr.; *Augenbrand*, Ger. A variety of anthrax which attacks the eyelids, sometimes in bad cases involving the destruction not only of the lids, but of the globe of the eye itself. It is a very rare affection, and is observed almost exclusively in persons who have long endured privations of every kind, and who have been addicted to intemperate and squalid habits. (See Anthrax.)

ANTHRAX, *ἄνθραξ* (coal) Gr.; *carbo*, Lat.; *anthrax, charbon*, Fr.; *Karbunkel*, Ger. By this term is designated the inflammation of isolated portions of the dermic cellular tissue. Anthrax presents itself as a circumscribed hemispherical hard tumour, more or less extensive, in proportion to the number of the cellular fasciculi involved; the centre of the tumour, at first of a dull red, soon assumes a livid or dark colour, which extends over its entire surface; the pain is at first but slight; it gradually increases till it becomes fierce and burning, and so continues until the excessive tension of the parts is taken off by appropriate treatment, or they become deprived of sensibility, by the supervention of gangrene.

The terms *anthrax* and *carbuncle* are often used synonymously. Dupuytren, however, has shown that their differences are more decided than had been supposed, and that they do not depend solely on the degrees of violence accompanying an attack. The gangrene that occurs in the pestilential carbuncle, or malignant anthrax, arises from the nature of the disease itself, namely, the absorption of some deleterious substance, while in the anthrax properly so called, it is simply a result of the constriction of the parts, and may to a great extent if not altogether be obviated by treatment.

Pathology.—In order to comprehend the mode in which this constriction of the cellular tissue is effected, it will be necessary to say a few words as to the difference of relation which that tissue presents in regard to the chorion, as compared with the state in which it is found, as strictly *subcutaneous*. The subcutaneous cellular tissue is free from the admixture of any other elements more resisting and inelastic than itself; but not so the cellular tissue of the derm. The deep-seated layer of the skin receives prolongations accompanying the vessels and nerves, from the subcutaneous cellular tissue, and which are lodged in its fibrous cells. Every areole or cell of the deep surface of the derm is thus filled with cellular tissue. If an inflammation attacks one or more of these cellular bundles, they become distended beyond the power of yielding of the fibrous areoles in which they are contained; while the cells in their turn compress and strangulate the engorged cellular tissue, and hence both elements are disorganized,—the fibrous cells from distension, the cellular tissue from strangulation. The same condition of parts characterizes furunculus; but in the latter case, the number of bundles of the cellular tissue affected is very small, seldom more than one or two. The only difference therefore, between anthrax and furunculus is one of extent; that of the former having sometimes a diameter and elevation of several inches.

Causes.—Anthrax is usually described as caused by irritating applications to the skin, or as a common coincidence, if not a consequence, of gastro-intestinal irritation. The predisposing causes, however, are often much more obvious than the immediate. Habitual excess in eating, with the abuse of fermented liquors, and disorder or want of tone in the assimilating organs, are enumerated amongst the causes that produce anthrax. It is also sometimes observed in the termination of measles, small-pox, and fevers of a typhoid character. Generally speaking, it occurs most commonly in those parts of the integuments which are thickest and best supplied with cellular tissue, on the back of the neck, the back, the nates, the thighs, the thorax, abdomen, axillæ, loins, and jaws. Unlike the furunculus, of which several may exist together, or follow each other in succession, the anthrax is usually single, more especially if extensive; there are, however, exceptions in this respect.

The progression observed in the phenomena belonging to this affection seems to sanction their classification into different periods or stages. In the period of attack, a pimple is first observed, the basis of which, small at first, rapidly extends. It is often not at all painful at the outset, the sensation being merely that of itching. Sometimes a small tumour exists before any pain or itching is felt, and is discovered only by accidental touching. Confined in the beginning to the cellular tissue of the chorion, the inflammation soon extends to the subcutaneous cellular tissue; the tumour which has the feel of brawn, gains on the surrounding surface in every direction, and seems almost immovable in the midst of the parts in which it has become developed. Over the most elevated points phlyctenes are formed, which breaking, give issue to a watery or sanious pus; and the cuticle peels off. The strangulation of the dermic cellular tissue is now at its height; the pain has acquired a peculiarly severe and burning character, and symptoms of constitutional reaction become manifest. The appetite is diminished, or null; the sleep disturbed, or altogether prevented, the stomach and bowels are disordered; if the tumour be very large, the skin is dry, the urine high-coloured and scanty, the headach is severe, and sometimes delirium supervenes.

Besides these features, which may be considered as general and characteristic, there are others which are accidental, and consequent upon the situation in which the anthrax is developed: thus the pain and tension are so great as seriously to impede the functions of the neighbouring parts, as of deglutition, or respiration, when the tumour occupies the neck, or the walls of the thorax, and of defecation, when it is seated in those of the abdomen, &c.

Except in the very rare cases in which resolution is effected at an early stage, this inflammation runs its course until it terminates in gangrene, both of the fibrous areoles of the derm, and the cellular tissue contained in them. Once reduced to this state, they form a core, or disorganized mass, which by means of a new process now set up in the surrounding parts, is ultimately eliminated. This is the commencement of the second period. The cellular tissue surrounding the core is engorged, lymph is effused, and pus, at first in small quantity, is secreted. If left to itself, the skin covering the tumour, deprived of its cuticle, grows thinner, till at last the fibrous cells are denuded, and the disorganized mass becomes visible through the fibrous partitions, which still resist its expulsion. One after another, these little inflamed bands give way, and a large aperture is formed, through which a soft whitish or grey flaky mass of mortified cellular tissue slowly advances. The pus which accompanies it is not abundant, but exhales a peculiar and very offensive odour. Towards the end of this stage, and in proportion as the disorganized mass becomes detached from the living parts, the pus increases in quantity, and exudes from the sides of the eschar on the slightest pressure. The dead parts are at length thrown off in mass, or flakes, leaving a suppurating cavity, large and deep in proportion to the loss of substance. When the destruction of the subcutaneous cellular tissue is extensive, the muscles, tendons, and aponeuroses are denuded, and sometimes the fibrous sheaths themselves are seen perforated, and purulent sinuses extend beneath them in various directions. After the expulsion of the mortified mass, the engorgement and induration of the surrounding parts persist often for a considerable time. The edges of the solution of continuity are of a livid hue, deprived of cuticle, and thinned to such a degree, from the destruction of the subcutaneous cellular tissue, that they often perish extensively, or, if preserved, show but little tendency to cicatrize.

In the third stage, the suppuration either diminishes gradually, granulations spring up from the bottom of the cavity, and cicatrization proceeds favourably, or extending further, the suppurative action is prolonged indefinitely, and the patient is exhausted by the excessive discharge.

The duration of the disease varies considerably, its progress in some being much more rapid than in others; generally speaking, however, it is in proportion to the violence of the attack, and the vigour of the patient. If the disease is extensive, the eschar is not formed till the twentieth, nor is it completely thrown off till the fortieth or fiftieth day. The suppuration and cicatrization may occupy, as has been already observed, an indefinite period.

Prognosis.—When the anthrax is extensive and rapid in its progress, especially if the constitution is much shattered, the prognostic is highly unfavourable. The reverse of these conditions, it need scarce be added, will justify a more favourable augury. The danger to life is relative to the age of the patient, the extent of the parts attacked, the violence and duration of the irritation, the exhaustion from long-continued discharge, and the situation in which the tumour is developed. This last point is one of the utmost importance, as the local irritation is readily transmitted to the neighbouring organs. It is on this account, that bad consequences are so much more to be dreaded, when an anthrax occurs in the vicinity of the great serous cavities; in the scalp, for instance, it is almost always fatal.

Local treatment.—When the surgeon is consulted at the commencement, and the tumour is not extensive, nor the pain yet severe, an attempt may be made, and sometimes successfully, to check its further progress by the application of numerous leeches, cold lotions, or emollient poultices. If the inflammatory irritation that first assails the cellulo-adipose pellets lodged in the areoles of the derm can be arrested, the disease aborts, and the patient is spared much suffering and risk. But when these measures fail to produce the desired effect, he must not lose time; promptitude and energy will be necessary not only to relieve the patient of pain, but to limit the ravages which the disease, if left to itself, would not fail to produce in the parts attacked. The inflamed cellular pellets, shut up in the unyielding cells, are suffering the passive pressure of the aponeurotic derm, and this pressure will go on augmenting till both perish together; a consequence which can only be prevented by freeing the parts from this state of strangulation. This is effected by multiplied incisions extending through it from the summit to the base of the tumour, and prolonged beyond its limits for a little way. The number of incisions should vary according to the extent of the tumour; the crucial or stellated form is that generally preferred. If they are made sufficiently early, the pain ceases almost at once, the duration of the disease will be greatly abridged, and the gangrene that would otherwise result will sometimes be prevented altogether. If matter has been already formed, it is squeezed out on the divided surfaces, and a good deal of blood is poured out, which helps to subdue the inflammation. The effect of crucial incisions in removing the constriction of the parts, and producing the cessation of pain, is well exemplified in a case of Dupuytren's. He first divided the tumour, which was about the size of a hen's egg, into two equal parts, one of which he again divided into two parts. These two incisions had the form of a T; the upper half of the tumour having been cut crucially, whilst the lower one remained undivided. As Dupuytren foretold, the pain ceased, and the inflammation was subsiding only in the upper half of the tumour, the lower one being found next day, still hard, inflamed, and much larger. The lower half was then divided, and its further progress arrested.

If the tumour happen to be so large, that the crucial incisions are insufficient to relieve the parts from constriction, then as many more as may be required are made, passing through the same centre as the two first, or in such other manner, as may seem best suited to the object the surgeon has in view, and the nature of the parts in which the anthrax is developed. It is important to bear in mind, that in order to arrest the progress of the tumour, the incisions should not only divide it completely through, but be prolonged a little way beyond it. The incisions having been duly made, and in sufficient number, either through the centre, or round the basis of the tumour, pressure should be made both on the tumour and the surrounding parts, in order to unload them of the pus and mortified cellular tissue which they may contain, and the whole is covered with an emollient poultice; sometimes a simple or digestive ointment is applied to the wound itself, and the poultice is then spread largely over the wound and neighbouring parts.

In some cases, the treatment by incisions is objectionable, on account of the situation of the tumour. When it is so, it should at an early stage be covered with leeches, and the bleeding encouraged by warm fomentations, or it may be cupped. The surgeon should then watch till the skin becomes thinned, and make a straight incision to give issue to the pus and gangrenous cellular tissue, and if one or more spontaneous openings have already formed they may be thrown into one by this incision. In pressing out the matter and sloughs, the degree of force employed should be moderate; for, setting aside the torture which severe pressure would produce, it would also retard the detersive and healing process by breaking up many small vessels. It will therefore be better to press the pus out gently at each dressing, and remove the flakes of cellular tissue as they become loosened and detached, than to force them away roughly. When the skin is extensively thinned by the progress of ulceration, it will not unite with the granulations that spring from the bottom of the wound. In this case the wasted integument, which is an obstacle to cicatrization, should be cut away with the scissors. When the suppuration diminishes, and the tendency to healing is obvious, care should be taken to watch the progress of the cicatrization, with a view to check exuberant granulations, or to prevent the parts from contracting adhesions, or taking positions which might afterwards interfere with the due performance of their functions. When the granulations have become regularized, and the edges have sunk to their level, they should be drawn near or into contact by means of adhesive straps, and dressed with lint, either dry, or spread with simple ointment; at this stage, the treatment being the same as that of any other wound with loss of substance.

Patients attacked with anthrax, under the impression that it is a mere boil, often refrain from consulting the surgeon, till finding that palliatives have no effect, they become alarmed, and present themselves, for the first time, with large eschars, accompanied by an abundant and extremely ill-conditioned suppuration. In such cases, great benefit will be derived in correcting the fetid state of the ulcer, from the use of the chloride of lime, either in poultice or lotion.

In situations where the treatment by incisions might be objected to, or where the anthrax shows a disposition to spread or become complicated with a diffused inflammation of the cellular tissue, blisters have been employed with a view to check the progress of the disease, mitigate the excessive pain, or maturate the pus in the tumour. When the inflammation shows a tendency to spread, it will be often arrested in this way, but in the circumscribed anthrax, the value of blisters is very doubtful. Dr. Physick of Philadelphia, however, states that in the early stages, they abate the burning pain for many hours, and may be repeated for this purpose; but he thinks they rather accelerate than retard mortification in the tumour, when applied in the second stage.

Neither in this country nor in America is the actual or potential cautery much resorted to in the cure of anthrax. Dr. Physick recommends the application of the potassa fusa in preference to the actual cautery in the second stage of anthrax; but though they calm the burning pain after a few hours, they are both inferior in value to that of the treatment by incisions, and should never be preferred to it, unless the pusillanimity of the patient, or some other weighty reason required it.

Constitutional treatment.—When the disease is observed to set in with symptoms of derangement in the digestive apparatus, aperients and tonics are exhibited. Many French surgeons combat the local and general symptoms, at the commencement of the attack, by total abstinence from food, and the administration of diluents and diaphoretics, with general as well as local bleeding in some cases. M. Perez relates some cases of anthrax successfully treated in this way. But it should be borne in mind, that in this class of patients there is oftener a want than an excess of power, and that the disease is more frequent amongst the aged and debilitated, than amongst the young and vigorous. In this country, general bleeding in anthrax, except in a case where the subject is young, plethoric, and robust, is not employed; local bleeding by leeches or cupping is often had recourse to at first; this is followed by poultices, till the incisions are made. In the second and third period, the strength of the patient is supported by a generous diet, with wine, porter, &c. Bark, camphor, æther, ammonia, mineral acids, &c., are administered internally, according to the necessities of the case. Opium is exhibited at every stage, more particularly in the first, to allay pain and procure sleep.

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ANTIMONY, (from ἀντὶ, 'against,' and the French word *moine*, 'monk;') a derivation referring to the imprudence of the monks, who, when the substance was first used in medicine, took it in dangerously large doses. *Antimonium, stibium*, Lat.; *antimoine*, French; *Spiessglas*, Ger.; *regulus of antimony*, Eng. It exists in nature either in a native or combined state. The antimony of commerce is chiefly derived from the sulphuret. The medicinal preparations of this metal are numerous, and are employed both internally and externally.

The tartarized antimony, or more strictly speaking, the tartrate of antimony and potass, in conjunction with lard, is frequently employed as a counter-irritant. The practice seems to have originated about the year 1773, with Dr. Bradley (Memoirs of the London Medical Society). Dr. Jenner also advocated the use of tartar emetic ointment. He recommended the addition of a small portion of white sugar to prevent it from becoming rancid. It may fail, however, altogether as a counter-irritant if care be not taken to reduce the tartar emetic to an impalpable powder previously to its being incorporated with the lard. Spermaceti may be substituted for the lard. The usual proportions are ʒj of the antimonial, to ℥j or ℥iss of the unctuous substance. A small portion of this ointment may be rubbed in night and morning. It may also be introduced by sprinkling the powder on fresh-made adhesive plaister, and applying it to the skin. The effect produced on the integument varies in degree from simple redness to vesication, and a more or less plentiful eruption of pustules, according to the thinness and susceptibility of the skin, and the duration and strength of the application. The pustules thus raised have some resemblance to those of small-pox, and often spread into a broad and deep ulcer. The ointment is used in most cases where greater permanency of effect is aimed at than can be obtained by vesication with cantharides. A solution of the salt may also be introduced endermically, the cuticle being previously removed by a blister. The external use of antimony is chiefly had recourse to in chronic inflammation of the joints, in deep-seated rheumatic pains, in bronchitis, and in pulmonary affections generally. Tartar emetic is also much employed to depress the vital powers, with a view, through the general relaxation thus produced, to favour the reduction of a luxation, the return of a hernia, the cessation of spasm in the mucous canals, &c.

The only other preparation of antimony employed in surgery is the protochloruret, *the muriat, or butter of antimony.* It is one of the most violent caustics we possess, and is employed occasionally in cauterizing the wounds inflicted by rabid animals, or venomous reptiles, as well as those received in the dissecting-room, in checking fungous growths, in destroying warts, vegetations, and carious bones. It should be kept in well stopped bottles, as it is liable to be much weakened and converted into a yellow oil by absorbing moisture from the atmosphere. It is conveniently applied by means of a roll of lint, which is dipped in the caustic at the moment of use. Its application to cancerous nodules is exempt from the dangers imputed to arsenic, for which it might be advantageously substituted; but it is liable to an objection of another kind, that of spreading beyond the parts to which it has been applied, and being, from the difficulty of limiting its operation, extremely unmanageable.

ANTIPHLOGISTICS (derived from ἀντὶ, *contrary to*, and φλόγωσις, *inflammation*). In its most extended signification, this term is applicable to all measures employed to subdue inflammation.

Under one head, however, would thus be included not only depletive, sedative, refrigerant, and emollient means, together with purgatives, nauseants, and diaphoretics, but remedies of a totally opposite character, whose therapeutic operation in inflammations is secondary or remote, as astringents and counter-irritants, topically applied, and the medicinal substances internally administered under the name of revulsives or contra-stimulants.

In order to avoid confusion, therefore, the term has been restricted to those agents only, which, by effecting an immediate reduction of vital action, whether locally or generally, are directly opposed to the conditions on which the phenomena of inflammation depend.

These may be enumerated, at large, as follows:—General and local abstractions of blood; purgatives, especially the saline; nauseating doses of emetic medicines; reduction of the heat of the body to its natural standard, by means of cooling, diaphoretic, demulcent, and sedative medicines and drinks; cold affusion; warm and tepid baths; regulation of the temperature of the atmosphere; repose both of body and mind; the topical application of cooling lotions, warm fomentations and poultices; and, finally, a diet more or less limited in quantity, carried even, for a time, to total abstinence, and mild as well as easily digestible in quality: all stimulating articles of food and drink being rigorously excluded.

This last is generally denominated the antiphlogistic regimen, and the combination of the whole forms the antiphlogistic system of treatment. (See INFLAMMATION, COUNTER-IRRITANTS, and CONTRA-STIMULANTS.)

(*Henry T. Chapman.*)

ANTRUM OF HIGHMORE, *antre d'Highmore*, Fr.; *Highmorshöle*, Ger. The name of a deep cavity formed in the substance of the superior maxillary bone. The antrum is lined throughout by the Schneiderian membrane, with which it is continuous, through its meatus of communication with the nostrils. (See MAXILLARY SINUS.)

ANUS. The opening by which the rectum terminates, and by which the excrement is eliminated; it is so named from its almost circular shape. The observations proposed to be made in this article will be mainly limited to the affections which implicate the terminal extremity of the alimentary tube. Those which involve the canal itself will be reserved for consideration under the respective heads of HÆMORRHOIDS and RECTUM.

Thus restricting the subject, it is scarcely required for its elucidation, to enter into anatomical details; but that important affection, *anal abscess*, which from its proximity is naturally associated with our present subject, forbids that we should entirely dispense with them.

The anal aperture is a rugous slit, situated, in a direction from before backwards, midway between the tuberosities of the ischia, and is hidden from view by the approximation of the glutei maximi muscles. To terminate at this point, the rectum advances from the sacrum, and, according to the sex of the subject, passes under the bladder and prostate gland, or under the vagina, where it turns downwards, and a little backwards, to offer the aperture in question. Its extremity is provided with two muscles, which, from their position, are termed *sphincters*, and one of which serves also to maintain it in its situation. One of these, the *internal sphincter*, is in direct contact with the mucous lining of the gut, and is, indeed, nothing more than an amplification of the circular fibres which exist in the rest of its extent, and with which its upper margin is continuous. On introducing the finger into the gut, as far as the second joint, the defined margin of this circular band of muscular fibres may be easily felt through the mucous membrane; and by the same mode of examination, it will be ascertained that its calibre diminishes as it descends from the bladder or prostate gland to the anus.

It is stated in the American Cyclopædia of Medicine[1], on the authority of Dr. Horner, the Professor of Anatomy in the University of Pennsylvania, that the external or longitudinal fibres of the gut do not insensibly disappear on their arrival at the internal sphincter; but, on the contrary, that the major part of them are continued on the outside of the sphincter, assume a tendinous appearance as they descend, and are accumulated into numerous fasciculi, which, passing under its inferior margin, ascend on the internal surface of the sphincter (but having a less intimate connexion with it than with the mucous membrane), and, finally, after again becoming obviously muscular, are inserted into the mucous lining of the gut as high as an inch and a half or two inches above the inferior margin of the sphincter. We have endeavoured to verify these observations of the American professor in two recent dissections, but we confess that we have hitherto failed to trace the reflection of the fasciculi from without inwards, and, consequently, their muscular termination in the mucous membrane. Should, however, the fact turn out to be as he has laid it down, its influence in producing prolapses of the rectum would be so apparent, and that affection so readily explained, that it merits the institution of more dissections than we have been able to make; and it is probable that in the article Rectum, we may be prepared to admit or disprove the assertion.

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[1] Part VI. p. 81.

The lower end of the gut thus tapered and provided with a thickened muscular coat, is received into the upper concave surface of a long elliptical muscle, in the centre of which there is a longitudinal slit. This is the *cutaneous* or *external sphincter*, a muscle which accomplishes the fixation of the end of the tube, by having its posterior angle attached to the point of the coccyx, and its anterior angle to that tendinous point in the perineum which is common to the sphincter behind, the acceleratores urinæ in front, the transversi perinei on each side, and the anterior fibres of the levatores ani above. In the female, its anterior angle is attached to the sphincter vaginæ.

The lower edge of the internal sphincter is received on the concave surface of the cutaneous sphincter, in such manner that the latter by the upper part of its circumference embraces the outside of the former muscle, and by the lower blocks up the aperture to the gut, there being nearly half an inch between the slit and the point of contact of the two sphincters, and which point of contact is marked by a distinct cellular line.

The rectum, with the bladder and prostate gland above it, is confined in the cavity of the pelvis, and the sphincter externus is excluded from it by a broad flat muscular septum, the pelvic surface of which is concave, the perineal convex, which, with a slight interruption to its origin at the symphysis pubis, is fixed to so much of the parietes of the pelvis as are anterior to the spinous processes of the ischia (being attached to the pelvic surface of the bodies of the pubis, and to the aponeuroses covering the obturatores interni, and the flat surfaces of the ischia which correspond to the acetabula) and behind, and on the median line, it is attached to, and supported by, the point of the coccyx. The narrow space which exists on each side the coccyx, between its edge and the sacro-sciatic ligament, is filled up by the ischio-coccygeus muscle. The anterior part of this muscular platform presents an infundibuliform opening lodging the prostate gland and giving exit to the membranous portion of the urethra; and, below this opening, another much larger, through which the extremity of the rectum is pushed in such a manner that the fibres of the edge of the opening intermingle with those of the sphincter ani. So much of the rectum as is beneath the bladder is adherent to a cellular line which extends backwards to the os coccygis, and which makes the division of this septum when it is described as consisting of two muscles, denominated *levatores ani.*

At the line which indicates the fixed attachment of the levatores ani, the pelvic fascia splits into three laminæ. Between the first two (counting from the cavity of the pelvis) is contained the muscles just mentioned, to which the aponeuroses are firmly adherent. The pelvic lamina quits the levatores ani, and attains anteriorly the neck of the bladder, where, by reason of its being pierced by the dorsal vein of the penis, it forms the two anterior ligaments of the bladder; more outwardly, the sides of the prostate gland and bladder, by an upward reflexion constituting the lateral ligaments of the latter organ; and, still more posteriorly, the sides of the rectum. The perineal lamina descends on the outside of the levatores ani degenerating in its progress so as to be scarcely perceptible on the posterior part of the rectum; anteriorly, it is confounded with the attenuated border of the triangular ligament of the urethra, is attached to, or rather contributes to form, the tendinous centre of the perineum, and glides behind or beneath the transversus perinei muscle to constitute the superficial fascia of the perineum; and, in its middle portion, it passes from the outer border of the external sphincter to be lost in the superficial fascia covering the buttocks.

The third or exterior lamina of the pelvic fascia is of a dense and resisting character, and contains within its substance the pudic and hæmorrhoidal vessels. It covers the perineal surfaces of the obturatores interni, binding those muscles against the obturator ligaments. Posteriorly, and on either side, it is received into the great sacro-sciatic ligaments; and more forward it becomes confounded with that portion of the preceding layer which passes on the external surface of the gluteus maximus. Anteriorly, it occupies the pubic arch, is attached to the rami of the pubis and ischia (constituting the greater portion of the thickness of the triangular ligament) assists in forming the central tendon of the perineum in front of the rectum and above the transversus perinei, and, at the posterior border of these muscles, unites with the perineal fasciæ of the levatores ani, where they are proceeding to form the superficial fascia of the perineum, in such a manner that the posterior border of each transversus perinei is lodged in the groove formed by the union of these two fasciæ, and it is this union which effectually excludes the anal from the urethral portion of the perineum.

The fascia of the obturator internus, and the fascia of the levator ani, form, by their union above and their separation below, a triangular space measuring rather better than an inch from side to side, and an inch and three quarters from before backwards. This space, on either side, is completely filled with adipose tissue supported by cellular bands, which are produced principally from the external face of the fascia of the levatores; and it is entirely closed in below by the overlapping of the gluteus maximus.

By the arrangement, the union and the attachment of these several fasciæ, it will be seen that not only is the anus fixed in its position, but that the connexion between the extremity of the gut and the urinary organs is so intimate and complete as to exclude the possibility of their separation; that, on each side of the rectum, there is a recess, having aponeurotic parietes in every direction, and still more completely closed by the union and degeneration of its fascial walls into the superficial fascia covering that muscle, filled with a material sufficiently dense to support that organ, yet so yielding as to admit of its volume being augmented; that in front of the rectum there is another but smaller recess bounded by the transversus perinei below, the deep fascia above, and by the line of union of the deep with the superficial behind; and, that the surface of the sphincter externus is not implicated with any other fasciæ, but is in direct contact with the skin.

The skin advancing from the commutual sides of the glutei becomes darker in colour, and finer, and more extensible in structure, as it approaches the anus, where it is gathered into plaits which soon vanish as they radiate from this centre. It is furnished with follicles, small but numerous, especially at the verge, which secrete the unctuous product that always bathes these parts, and where the nates rub against each other the skin is provided with a quantity of soft hairs.

The vessels which supply the anus communicate freely with those which are distributed to the intestine itself, and like them they form a plexus around the organ. The veins, especially, are reticulated in the submucous tissue, and are very obvious within and about the verge when the circulation is retarded. The arteries which interest us at present are a few branches, irregular in their number, which proceed from the *internal pudic* immediately on its entrance into the triangular space on the side of the rectum. These, under the name of the external hæmorrhoidal artery, supply the integuments and external sphincter, and, by ascending ramifications, they inosculate with others which proceed from the middle or lateral hæmorrhoidal.

Accompanying the external hæmorrhoidal artery are the venæ comites, which terminate in the external pudic vein, but the transit of the blood is mainly through the plexus formed by the middle and superior hæmorrhoidal veins, so that in returning to the heart it takes the route of the portal system.

This part is supplied with nerves of animal life, and with nerves of organic life; the former are derived from the sacral plexus through the medium, principally, of the inferior branch of the pudic nerve; the latter proceed from the hypogastric plexus of the great sympathetic nerve. In the distribution of both these classes of nerves the bladder and the rectum receive their supply in common, thereby associating them in a disordered as well as in a healthy state, and affording us a clue to the explanation of phenomena that present themselves when either organ is disturbed and which otherwise would be unintelligible.

ANAL ABSCESS.

That abscess in the neighbourhood of the anus should be of frequent occurrence, might be anticipated from a contemplation of the functions to be performed and the organization provided for their accomplishment. The volume of the rectum is ever varying, and the artificial habits of civilized life cause it to be the seat of stercoral accumulations, which become irritative, not only by retarding the blood in its passage to the heart, but, also, by their mechanical influence on the intestine and the adjacent structures, the nature of which is such as to favour, to the greatest extent, the formation and the accumulation of pus. The circumstances under which the gut is shaped and fixed, render it liable to occasional perforation; for foreign bodies which have been taken into the stomach will sometimes be arrested here, after having innocuously traversed the rest of the tube, and, by perforating, if the body be spiculated, or by ulceration if it be obtuse, become lodged in the cellular tissue which occupies the ischio-rectal space; and in like manner, also, is abscess produced, by the careless or violent introduction of foreign bodies, such as glyster-pipes, bougies, &c., *per anum*. The parts between the ischia are, from their situation, exposed to injury from kicks, falls, &c., and force so applied frequently produces an abscess of a grave description. Tumours, originating in a stasis of the blood in the veins of the anus, and oftentimes becoming the sources of abscesses, do not depend entirely on the accumulation of hardened fæces. The chief part of the blood passes from the veins of this organ into the inferior mesenteric vein, and whatever may arrest or retard the circulation in the portal system, whether it be the altered structure of the liver, pancreas, or mesenteric glands, the blood will be dammed up in the anal veins, thus constituting irritative tumours. (See Hæmorrhoids.)

But it is not so much to the causes, as to the nature, locality, and consequences of abscesses about the anus that our attention will be directed; the general doctrine of their formation having been treated in the article Abscess.

The existence of so much cellular tissue, bolstering up the sides of the extremity of the rectum, is favourable to the production of phlegmonous or carbunculous abscesses; and the abscess will be the one or the other, according to the tone or atony of the organism, or as the action may be moderate and continuous, or excessive and sudden.

The situation in which they prevail are the ischio-rectal spaces between the levator ani and obturator internus muscles; between the two laminæ of the pelvic fascia which embrace the levator ani, and consequently involving the muscle itself; in front of the rectum and above the transversus perinei muscle; and, lastly, between the margin of the internal and the superior surface of the external sphincter muscles themselves.

1. *Phlegmonous Abscess.*—Abscesses of this description occur in all the situations we have just indicated, and, in most instances, it is by no means easy to determine the cause which has produced them. Whether the inflammatory action which precedes and is coincident with their appearance be established by the local irritation, or, whether the febrile excitement relieve itself by the formation of pus in these parts, as it often does in others, may admit of doubt, but affects not the question of functional disturbance or the means of relief.

The usual indications of a phlegmonous abscess, redness and swelling of the part, are not always, in the first instance, to be observed; and we are often able to detect the existence of matter before any external sign is apparent. To the general disturbance of the circulation heretofore described (see Abscess) are added phenomena which depend for their production on the peculiar functions of the neighbouring organs.

When the matter is deposited between the embracing laminæ of the levator ani, the tumour formed by it encroaches on the rectum and diminishes its capacity, offering a physical impediment to the expulsion of the fæces; the performance of which act, during the inflammatory stage which preceded the elimination of pus, was attended with aggravated suffering, being, now that the canal is narrowed, accompanied by such unbearable torments that every effort which the will can make is employed to resist the impulse to evacuate the bowels. The bladder, too, becomes implicated to a greater or less extent. Commencing with a simple, but often repeated desire to urinate, its sympathy augments as the disease advances; dribbling of the urine is superadded to the desire to urinate; and complete retention occurs when the tumour attains a large size. This last phenomenon, however, does not so frequently occur when the matter is situated laterally to the rectum, as it does when the abscess is formed in front of that organ.

All this functional disturbance may be produced without any external indications of the nature of the affection; or, if there be any, they are of so uncertain a character as not to be depended on. The finger, and the finger alone, introduced per anum, will announce to us the condition of parts; a fact which enforces the necessity of instituting this mode of investigation at the outset of any affection which may interfere with the functions of the bladder or rectum. This is still more impressed on us by a consideration of the effect of matter, so pent up, on the rectum itself. On the one hand, we have a fascia of some density, supported on its outer side by a cushion of cellular tissue, which prevents the extension of the walls of the abscess in that direction, save by the successive agglutination of the tissues; and, on the other, we have the rectum readily yielding towards its cavity and opposing little resistance to the extension of the abscess on that side. It, therefore, becomes a point of deep importance to make an exit for the pus by bold and prompt incisions through the integuments; everting the gluteus maximus, and cutting by the side of the rectum so as to penetrate into the ischio-rectal space. If this procedure be deferred until the fluctuation can be appreciated externally, one of two things will happen; either the abscess will open into the rectum, or that gut will be so thinned as to expose its mucous coat, and thus render unavoidable its division so as to form one cavity of the abscess and the rectum. (See Fistula.)

2. Phlegmonous abscess occurs, also, in the ischio-rectal space, on the outside of the fascia of the levator ani muscle; but it is of a less alarming character as respects the implication of the rectum and bladder in this, than in the former, situation, though equally so as regards its ultimate effects. The nature of the tissue contained in it favours the accumulation of pus when once it has been secreted; but, as it is not bound so closely to the rectum and bladder as, in fact, the levator ani and its fasciæ intervene between the abscess and those organs, their functions are not necessarily impaired at the commencement of the deposition. The same urgency, however, exists for the speedy and complete opening of the abscess. By neglecting to open it, the cavity rapidly extends itself, and an immense reservoir of pus is established which is not always restricted to one side; but, on the contrary, sometimes passes behind the rectum to the opposite ischio-rectal space; and instances are not wanting in which the rectum has been completely dissected out and left pendulous in a pool of pus.

The matter accumulates more upwards than downwards by reason of the impediment offered by the union of the fascia of the levator ani with that of the obturator internus, at the line where they commence their joint descent, behind the transversus perinei muscle, on the surface of the gluteus maximus. Hence, by being long pent up, the matter separates the fibres of the levator ani and the muscular coat of the rectum; laying bare the mucous membrane, as in the case before mentioned, and rendering the same division of parts necessary. The arrangement of the fascia on the gluteus maximus explains the reason of the peculiar formation of the tumour. Though circumscribed, as in other parts, it is not defined, and its base is lost in the muscle through which it is felt.

It has been a question on which surgeons have been divided in opinion, whether the operation should cease on the free liberation of the matter, or be continued to the division of the gut. It appears to us that the question admits of no dispute; for, if the rectum be not denuded, and a full and fair incision be made into the abscess, the cavity will, in the majority of cases, be filled up without the intervention of a severe, and, in that case, unnecessary operation. Nay, should the mucous membrane be laid bare, is it not in opposition to every principle of surgery to perform an operation which would entail the necessity of cramming extraneous, and consequently, irritating materials into parts already irritated to an unnatural degree? For it must be borne in mind, that to carry out the principle of such an operation, the walls of the cavity, both incised and purulent, must be kept separate to ensure its granulating from its deepest surface; and we know that where, as in fistula, the inflammation that prevails in the cavity has assumed a chronic form, the introduction, — the necessary introduction,—of a foreign body frequently lights up great constitutional as well as local irritation. But here there is nothing chronic; the plastic operations of nature are in their greatest state of activity, and to interfere with them is to thwart their efforts by re-exciting a tumultuous action which would destroy the newly formed granulations. And here the questions arise how much of the reparation are we to leave to a natural process? and how much are we to take into our own hands? We must either make the connexion between the gut and the abscess at the greatest depth of the latter, or there is some point of limitation. Seeing that the abscess sometimes extends as high as the line of union between the two fasciæ which form the walls of the recess, in other words, as high as the origin of the levator ani, it is obvious that we cannot make the incision there; and, if we stop short of that, it is difficult to conceive the soundness of a doctrine which does not equally apply to the treatment of the upper and to that of the lower part of a cavity.

It appears to be a more discreet proceeding to limit our endeavours to a decided and ample liberation of the contents of an abscess (for it is the feeble and imperfect opening which usually is followed by these fistulous drains) and, without attempting to inquire into the state of the gut, to suffer the patient to remain tranquil that the disturbance of the system may subside, and the parts be restored to a degree of composure. Whether an operation may ultimately be necessary, or whether it may be altogether dispensed with, there is this great advantage gained by delay, that a chronic will have supplied an acute action, and the dressings and passage of the fæces will be more readily tolerated; while, further, a considerable portion of the cavity will be filled up and the point for perforation accurately pointed out.

We would not exempt from this condemnation, notwithstanding the high authority of its proposer, the plan recommended by Velpeau of opening the abscess, when it involves the levator ani, from the interior of the rectum by means of a probe-pointed bistouri, so guarded as to avoid wounding the anus and lower part of the gut. It is difficult to ensure that the incision shall extend to the deepest part of the abscess, and, if it do not, we only make an aperture into a cavity into which the fæces will readily make their way; and even if we accomplish the full division of the parietes of the abscess, the stercoraceous matter would yet insinuate itself between the edges of the incision, and thus, by fomenting an inflammatory action and the burrowing of pus render ultimately necessary a complete division of the sphincters. It is possible that in a few solitary cases the restorative process may be carried, by these means, to a successful issue; but it appears to us that they will not justify the substitution of such a plan for one which is far more safe and less likely, if it be properly performed, to entail future annoyance on the patient.

We say, "properly performed," inasmuch as the chief cause of incomplete success attending the operation of opening from below, arises from the system of puncturing rather than incising the parts; thereby affording a facility for the lodgement of pus, the retention of which carries on the work of devastation in the same way as does the introduction of fæcal matter in the operation advocated by Velpeau.

3. Phlegmonous abscess is sometimes situated in front of the rectum. When so situated, the bladder suffers more than the rectum, for the tumour presses directly beneath the prostate gland, and the membranous portion of the urethra, against which it is principally directed by reason of its being confined by the deep fascia of the perineum above, the transversus perinei and superficial fascia below, and the union of the two fasciæ behind. By this union of the fasciæ the tumour is prevented encroaching on the rectum, and, by the same cause, its accumulation is directed upwards and forwards to the urethra. There is some pain in the act of defecation, but not of so aggravated a kind as when the matter is situated on the side of the gut; but the retention of urine by the occlusion of the urethra arrives more speedily, and is more complete than in the former instance.

An incision, like unto the first in the operation of lithotomy, but not extending so far back, should be made in the perineum, and carried into the space between the accelerator urinæ and erector penis, dividing the transversus perinei so that the pus may be entirely emancipated. This should be done so soon as the bladder betrays distress; for, by delaying it, there is considerable risk that the bladder will be relieved by a rupture of the urethra, its contents being poured forth into the perineum and scrotum.

An elderly gentleman, who has been some time under our observation, has suffered for the last thirty or forty years under an affliction, the consequence of such negligence. As far as can be gathered from him he was suddenly, and without apparent cause, seized with violent pain, accompanied with a sense of weight in the perineum; his bladder became irritable, and, in a short time, his urine was suppressed. The perineum in front of the anus was hard and tumid, and leeches were liberally applied. He has no recollection of being much incommoded in passing his motions, but he does recollect that his intolerable agony was assuaged on obeying a simultaneous desire to urinate and evacuate his rectum. The urine he describes as being offensively strong, and from his rectum had passed a considerable quantity of matter. From this time his urine flowed freely, but pus continued to drain from his anus and to pass with his stools, and, after the lapse of a considerable period, (he cannot say how long) the major part of his urine passed, per anum, though some of it continued to be discharged easily through the natural passage. Subsequently to this, whenever he took laxative medicines, a portion of his fæces passed through the urethra, and in this condition he continues to the present day. At all times a quantity of urine is discharged when he evacuates his bowels, and, whenever they have been acted on, his urine is always turbid with fæculent matter, and sometimes small portions of excrement temporarily stop up the urethra.

In the foregoing case it is probable that the urethra had been denuded before the bursting of the abscess into the rectum, so as not to be able to take on the granulating process by reason of which the cavity of the abscess was incapable of being closed, and a fistula was established in its stead. This must have been accomplished before the imperforate end of the canal was absorbed, or otherwise there would have been an infiltration of the perineum, which there was not; but the water steadily proceeded then, as it does now, from one organ to the other. A knife, employed in the early stage of the deposition, would have saved this man nearly half a century of annoyance and many years of suffering.

4. In the immediate region of the anus abscesses frequently occur which, though of the same nature, are, when contrasted with those enumerated in the preceding sections, of trivial import.

Oftentimes they are situated in the integuments, and attention is drawn to them by an uneasy itching sensation, when the finger detects a hard roundish pimple, which sometimes disappears of itself, but at others continues; although, becoming softer, no further notice is taken of it until an unusual moistness of the parts, or the tinged condition of the linen induces the patient to solicit surgical examination. There is then found, on separating the nates, a very small aperture admitting frequently of only an eye probe, which may be passed under the skin, and will ascend with it within the verge of the anus, where it most commonly ends in a *cul de sac.* If the aperture cannot be readily found, by pressing the ball of the finger around the margin of the anus, we may succeed in disengaging a portion of the discharge which will thus betray its locality. In the majority of cases, frequent ablution, alone or followed by an application of a solution of the sulphate of zinc, will suffice to cure them without the formality of an operation: and even when they do open into the canal, they frequently disappear of themselves, though they labour under the disadvantage of receiving into them the secretions of the gut.

When the tubercle is somewhat larger, and by its size and hardness, is exposed to attrition with the opposite buttock, it is well to transfix them at once, that by dividing them the engorged tissue may relieve itself and suppuration be forestalled.

These hardened tubercles often occupy the cellular line which is interposed between the two sphincters. They may originate in a point of congestion in the cellular substance, but it is more frequently from a consolidated hæmorrhoid taking on the suppurative action that abscesses of this description spring. These should never be suffered to remain unopened, since, should they open and discharge themselves into the lower part of the rectum, the matter would still extend itself to the integument; and, indeed, it is by this means that they constitute the main source of ordinary fistula. (See Fistula.)

5. Considering the ravages which these abscesses effect, it becomes an imperious duty of the surgeon to endeavour, in the first instance, to prevent their formation by a prompt, judicious, and untiring application of those means which are calculated to relieve total congestion, and to reinstate the balance of the circulation; and, in the second, when these measures have failed, to modify them in such manner as will lead to the next most favourable termination.

There is generally no want of power in those who are thus attacked, and, therefore, that universal feverishness of action which attends tonic congestion, in parts more yielding and less embarrassed, is, in these cases, of a most exalted and positive character, and must be met with corresponding energy by general and local treatment apportioned to the exigencies of the patient. It may not, in some instances, be possible to prevent the deposition of pus, but it is possible to modify the local as well as general activity, to limit the quantity of pus, when once formed, and to restrict its evil effects; and, above all, to soothe the irritation which reacts on the cause from which it sprung.

General bleeding at the onset; a liberal and often-repeated application of leeches to the parts around the anus and the pubis; puncturing the hæmorrhoidal veins, should any be distended; applications of the hip-bath, supplying, by a tube, hot water, so that when the patient emerges from the bath the water may be hotter than when he was first immersed in it; fomenting the perineum and genitals in the intervals, will frequently recompense the trouble they occasion by restoring the integrity of the attacked structure. But even if they do not effect this, they will enable the patient to urinate, to evacuate his bowels by the aid of some unstimulating laxative, without torture; and, by stimulating the vessels of the skin, blood will be retained at the surface of the body which would otherwise be determined internally.

When it is suspected that the first object has failed, and that pus is formed, it is yet competent to the surgeon to keep the action within just bounds, by the occasional and modified use of some of these means, until such time as matter is unequivocally manifested, and manual aid demanded.

6. *Carbunculous abscess.*—The cellular tissue occupying the ischio-rectal spaces, though admirably adapted for the formation and extension of phlegmonous abscesses under ordinary circumstances, is not sufficiently organized, in many subjects, to resist a sudden influx of blood; so that the arterial impulse which, in one person, will merely congest the part preparatory to the formation of abscess, will, in another, destroy the vitality of the structure.

External force, or the introduction of a foreign body, will effect this without reference to the tone or atony of the parts; but, whenever it is idiopathic, it occurs in subjects in whom the vital force is feeble, whether it be from original delicacy of organization, from long-indulged habits of intemperance, or from protracted suffering.

When it arises from the first cause, a tumultuous action is set up in the system, such as obtains in phlegmonous abscess; and it is therefore necessary, in every case in which the tissues about the rectum are concerned, that an investigation be made, whether external violence, or the introduction of a foreign body be implicated in its production; because, to pursue, in these cases, the energetic treatment which phlegmonous abscess demands, would speedily reduce the body to that state of atony which prevails in idiopathic carbunculous abscess.

Forewarned that one of these two accidents has occurred, it is advisable to husband the strength of the patient by avoiding unnecessary depletion; yet, at the same time, it must be borne in mind, that, if the arterial impulse be not tempered, the tissues adjoining the part which has already been destroyed, will lose their vitality in the same manner, from the inordinate ingress of blood. The extent to which these measures may be carried, and the point at which the surgeon should pause and institute a treatment exactly in opposition to the former, must be entirely a matter of judgment, without the exercise of which, all rules, however speciously paraded, will be unavailing.

The idiopathic carbunculous abscess generally supervenes on a long-continued illness, in which the body has, either from the wearing-out nature of the affection, or the treatment pursued, been enfeebled in its powers.

When the arterial excitement consequent on accidental carbunculous abscess is allayed, and the devastation arrested, it will be in the same state, and subject to the same management as the idiopathic, with this difference in favour of the former, that, as there is a greater vital force at the commencement of the disease, there is a greater chance that the plastic operations of nature may prove successful.

The affection is usually limited to one side. The bladder and rectum sustain but little disturbance, when contrasted with the sufferings of which they are the seat in phlegmonous abscess. The tumour has no defined limits, vanishing insensibly into the buttock on one side, and laterally to the rectum on the other. It is quaggy to the touch, to which it communicates but uncertain evidences of fluctuation. The skin becomes livid and assumes an erysipelatous character; small orifices appear on it, through which a probe may be passed to almost an indefinite extent, and from which a small quantity of unhealthy pus exudes; the skin between some of these orifices is absorbed, by which means they coalesce and form larger openings, and thus the interior of the cavity is displayed. This is occupied by a mass resembling sodden whity-brown paper, infiltrated with pus; and it is this mass which nature has to detach from the living structure.

Such carbunculous abscesses appear in other parts of the body, but under more favourable circumstances, inasmuch as there the adjacent structures are vascular, and therefore competent to the speedy absorption of the living surface in contact with the dead mass. In the ischio-rectal space we have fascial walls slenderly vitalized, and in which the action, necessary to disunite them from the gangrenous contents, is almost sufficient to effect their own destruction. If, in addition to this, we take into account the pressure which is made on the living surface by the binding effects of the skin (a pressure which inevitably disorganizes the small vessels distributed on it), we can understand why the amount of labour thrown upon nature is so great, and why the constitution should give way under the attempt at its performance, when the process is unassisted by surgical means.

So soon as the finger can appreciate the soft quaggy condition of the tumour, it should be immediately opened, parallel to the anus, from one extremity to the other; and, after the application of the usual anodyne fomentation, the nates should be placed in a poultice of boiled linseed meal and lard, thick in quantity but rather thin in quality; and the poultice and nates should be placed on an annular bolster (similar to that which a milk-maid employs to support the pail on her head), that the pus and shreds of decomposed cellular tissue may descend into the poultice by their own gravitation.

When by such a liberation and the employment of such means, the local irritability has subsided, an assisting impulse may be given to the local action by adding muriate of ammonia, or spirits of wine, or of turpentine, to the fomentation, and by substituting the grounds of a beer-barrel for water in the poultice.

At the same time, the powers of the system must be aided by a liberal administration of permanent stimuli, as animal food, quinine, porter, and wine; and, if the prostration of strength be great, and the danger urgent, transient stimuli, such as opium, brandy, æther, and camphor, must be resorted to to uphold the system, until the permanent stimuli, by acting upon it, shall render their further employment unnecessary.

Nevertheless, it will often happen, in the cases of persons who have resided long in large towns, that, however judiciously they may have been treated, though their lives may be saved, they will require a protracted residence in the country, with all the attendant circumstances of comfort and generous living, to complete the cure and restore them to strength.

EXCRESCENCES.

Tumours, such as are met with in other parts of the body, are developed in the neighbourhood of the anus, being sometimes within, at others upon, but more frequently below, the verge.

Immediately within the verge of the anus, but more properly belonging to the rectum, there are often produced *polypous elongations of the mucous membrane*, which have a soft, spongy appearance. These, which at times have a broad, and at others a pedicular attachment, are not always apparent until the patient makes great expulsive efforts; but they are easily detected by the finger, and not unfrequently they emerge, prior to the evolution of the fæces. They rarely demand manual aid for their removal. A solution of sulphate of zinc, or the introduction of a piece of a candle, smeared with an ointment containing powdered galls, or the application of a solution of nitrate of silver, when the tumours are extruded, will suffice for their dispersion, and oftentimes they are detached of themselves.

Warts are found on the circumference of the anus, and are productive of great inconvenience; the irritation they excite being sometimes so great as to affect the general health. They are not always confined to the circumference, but extend occasionally to some distance within the anus. By touching them occasionally with any of the strong acids they will fall off, but it is more advisable, and a much readier mode, to snip them off at once.

Schirrous, encysted, and fungoid tumours occur on, and in the neighbourhood of, these parts; but they offer no peculiarity to demand a special consideration in this place.

Condylomatous tumours occupy the skin adjoining the anus, and appear to be produced by the extension of the irritating fluids from the genitals. They have the same appearance as they present in other parts, save that they are more flattened by the rubbing of the nates, and they yield to the same mode of treatment.

RELAXATION OF THE ANUS.

The anus, instead of presenting a corrugated line deeply situated between the buttocks, is sometimes totally effaced; and the faces of the buttocks glide without interruption into the gut, so as to represent an inverted funnel; or the margin of the dilated aperture is loose and flabby, and hangs somewhat downwards. In the former case the sphincter has lost a considerable portion of its tonicity, but its functional power is not altogether destroyed; in the latter, its utility as a grasping muscle is entirely lost.

Whatever has a tendency to impair its association with the nervous system will necessarily produce relaxation of the sphincter, and in affections of an exhausting character, the broad shoulder of a glyster-pipe will pass without impediment into the rectum; but this condition being merely a symptom of some other affection, will not require further notice. Neither is there any practical utility to be derived from dwelling on that dilated condition which is produced by the revolting practices of those wretched monsters, who, setting at nought the impulses of nature, place themselves out of the pale of society.

A descent of the rectum or hæmorrhoidal and other tumours by their continued pressure within the sphincter will impair, and perhaps destroy its contractility, so that when the cause is removed, there yet remains a difficulty in retaining the fæces. A long continued use of astringent lotions, such as decoction of oak-bark with alum, and dashing cold water on the part, may possibly restore the tone of the muscle; and, by pinching up and cutting off several of the folds about the verge, the diameter of the orifice may be so far diminished by their cicatrization as to secure a certain degree of comfort to the patient.

SPASM OF THE ANUS.

"It has often occurred to me to remark, and has been observed by others," says Copeland, "that cases, which are called strictures of the urethra, and of the œsophagus, admit of more easy, more certain, and quicker relief, by the use of the bougie, than they could possibly do if the structure of the membrane of those canals were disturbed, as in cases of real and permanent stricture. Such diseases have usually been called spasmodic stricture. If the other canals of the body are affected, and their functions deranged by the mere spasm of their muscular fibres, it seems yet more probable that the rectum, surrounded at its extremity by a very powerful muscle, should be liable to a similar affection[1]."

Spasm of the anus, it seems probable, is mostly the consequence of some preceding morbid irritation, situated either in the gut itself, or in some of the organs with which it is interested; and it consequently ceases when that irritation has been removed. Such is the case when the urinary or genital organs are excited; for though the sphincters (especially the external one) always participate more or less in the disturbance of those organs, their spasmodic action ceases when the others have regained their quiescence.

There appears, however, to be produced, sometimes by an insidious and long-continued irritation in the intestine, or by the degrading broodings of a licentious mind, a spasmodic condition of the extremity of the rectum, which becomes a cause of its own continuance, by reason of the inflammation which has been set up in the parts, and which their state of activity will not allow to subside. In this condition, when by removing the cause alone we do not remove the effect, the affection merits a place in a dissertation on the diseases of the anus.

This affection, at its commencement, is announced by a deep-seated uneasy grasping sensation, and a feeling as though the anus were drawn upwards. Great restlessness prevails, and the patient either hurries about the room rubbing the part forcibly with his finger, or sits with it pressed on the edge of his chair. He flies to the water-closet, and makes ineffectual attempts to empty his bowels, and then he begins to alternate the former means again, until the spasm gives way, and a stool, generally of a costive character, is obtained.

In a short time it acquires a character of periodicity—a character which, in its greatest state of aggravation, it never entirely loses—and it generally makes its attack at night, awakening the patient from his sleep, or preventing sleep altogether in the early part of the night. When this periodicity is established, there comes on a smarting pain, as though the anus had been excoriated by excessive purgation, and this pain becomes more and more of a burning character, until it is intolerable.

On examining the parts, the sphincter is found powerfully contracted, so much so, that it is only with much difficulty and torment that a small bougie can be made to penetrate. When, by appropriate agents, the spasm is so far overcome as to permit the introduction of the little finger, great heat is found to prevail in the interior, and the internal sphincter as well as the external is felt tightly grasping the finger.

The inflammatory congestion of a part possessing such strong and numerous sympathies, explains at once the fearful symptoms which attend it. The language of the patient appears to be exaggerated, and when he compares the sensation to that produced by the lodgement of a red-hot iron in the gut, or to the tearing it out with fish-hooks, it may seem strange that such should be the case, more *after* than *at* the time of the expulsion of the fæces. But we must remember, that it is only to the most urgent calls of nature that he attends, and that the solid fæces in their descent, a descent accomplished by violent abdominal contraction, stun or blunt the energy of the nerves, and so effect their exit with comparatively little pain. When, however, they are expelled, re-action takes place, the nerves re-acquire their sensibility, which is for a time exalted proportionally to its previous depression, and, until this state subsides, the paroxysm endures.

The fæces are not discharged regularly; they are sometimes in flattened pieces, like tamarind stones, at others they are in strips like casement-lead issuing from a mill; and, occasionally there bursts out suddenly a mass of fæces, fluid, and mucus. The difficulty and distress attending this operation is shortly followed by intense suffering, "Perhaps there is no disease that the human frame is subject to which is more painful: the involuntary contractions of the sphincter are compared to the pains of labour; they frequently come on immediately, but more usually about an hour or more after each evacuation, and sometimes continue till the succeeding one. In some instances, the complaint goes on to produce suppuration and consequent fistula. Sometimes the irritation is propagated to the neck of the bladder, and produces a retention of, or impediment to, the urine. I have seen it in two cases extend up the canal, and give rise to attacks of violent colic, and an increased secretion from the whole inner membrane of the gut, so that an evacuation of mucous cylinders, of the size of the part of the canal where they are formed, or of detached pieces of mucus, are seen mixed with the fæces[1]." The act of coughing produces the greatest distress, and the expulsion of wind immediately brings on a paroxysm almost as violent as that attending the dejection of the fæces. To ride on horseback is impossible, and even the sitting posture can be endured only by the patient's twisting himself so as to press only on one buttock.

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[1] Copeland's Observations, p. 45, ed. 3.

[1] Copeland, Op. cit. p. 51.

To relieve this affection, Mr. Copeland recommends the use of opium and the introduction of bougies, observing that "when the muscle has been dilated and extended several times, it more easily yields to the stimulus of the fæces, and no longer affords the strong impediment which it had heretofore done; or its fibres, which had not perhaps a contemporary action, assume a more regular dilatation or contraction, and the symptoms subside[1]." And he appears to found this recommendation on the well-known susceptibility of the sphincters to be dilated by artificial means, even to the extent of admitting the whole hand into the rectum.

Deferring much to the opinion of this experienced surgeon, we yet apprehend, that, in the aggravated form of the disease, the introduction of a bougie is unscientific in principle and inapplicable in practice.

We assent to the proposition in the "earlier and lesser degrees of inconvenience which it produces;" in that stage, in fact, on which inflammation supervenes, and in which there is spasm, and spasm only, produced by some irritant. The patient even discovers of himself, without knowing the reason, the power which pressure exercises over the disease; and therefore he rubs his fundament, or squeezes it on the edge of a chair until he obtains relief; and if the end of a bougie be introduced at such a time within the spasmed sphincter, the muscle will soon expend its energy on that instrument. If then the wider part of the instrument be introduced, the natural tone of the muscle may be so far exhausted as to render it unlikely it will so soon resume its spasmodic action; and time will therefore be afforded for the institution of such measures as will remove not only the offending matter, but the condition of the organs which caused its detention, and thereby the intestines may be solicited to resume a regular action.

But it is very different when congestion and inflammation have supervened. Pressure, instead of affording relief, produces great pain; the patient not only does not rub the part, but he is frightened at the sight of his surgeon lest he should touch it; and it requires a strong exercise of the mind on the part of the sufferer to refrain from springing off, when the surgeon's finger approaches his anus.

Here the spasm, originally the cause, is now the consequence, of inflammation; and the adoption of means which were suitable before its supervention, can only tend to increase it, while it is the surgeon's aim to diminish it in the soonest possible time.

Yet, in attacking the inflammation, it is to be borne in mind that we are dealing only with an effect; and we must not lose sight of the obligation to attempt at the same time the removal of the first cause.

The surest and readiest mode of producing present relief, and of placing the patient in a favourable situation for the administration of those means which will restore the integrity of the digestive apparatus, is by dividing the sphincter on each side in the manner pursued in congenital occlusion of the anus. Not only is the sphincter rendered powerless, but the vessels of the congested tissues are emptied of their blood by these incisions, and the local tranquillity which is thereby induced affords the surgeon ample time to accomplish the no less important object of preventing the recurrence of the affection.

In some cases, where the inflammation has not attained so great a height, it is possible to dispense with the operation, by putting the sphincter into a state of temporary paralysis by means of the extract of belladonna diluted with the liquor plumbi diacetatis. This applied round the anus will effect such a relaxation of the sphincter as will admit of the finger, smeared with the same preparation, being introduced into the rectum; and the neuralgic condition of the parts which keeps up the inflammatory action being for a time annihilated, there are reasonable grounds for hoping that by the administration of mucilaginous glysters, the application of leeches, or the puncturing of the distended veins about the verge, and by the proper employment of a hip-bath, the severer operation may be prevented. And even should a disposition to relapse be manifested, a repetition of the application will prolong this artificial repose, and enable the surgeon to continue his efforts to dislodge the offending contents of the intestinal canal.

In the administration of glysters it is important to bear in mind the danger which attends an attempted introduction of the pipe of the instrument during a state of spasm. It is calculated to produce severe mischief in the interior of the gut by its sudden projection on overcoming the obstruction it encounters at the orifice; and it is to be feared that, by its traction on the skin of the aperture, it may split it and produce that complication of this affection which has been described by Boyer under the name of fissure of the anus, and to which we shall immediately advert.

On no account, then, should a glyster-pipe be pressed against the orifice of the anus until the spasm shall first be overcome by other means, and even then it should be introduced with great care and gentleness.

There is a great probability that persons who habituate themselves to this mode of relieving their bowels do injury to themselves, sometimes by their clumsiness and sometimes by their haste, in consequence of the pipe being formed of one unyielding piece. If the tube were composed of two parts, so that the portions destined to enter the rectum should be connected with that attached to the syringe or bag by the intervention of a cylinder of caoutchouc about an inch in length, the terminal extremity would, by reason of the flexibility of the connecting material, be enabled to turn aside when it met with opposition, to find, as it were, its own way; and to adapt itself to the direction of the cavity of the gut; thereby avoiding the possibility of wounding either the anus itself or the parts beyond it.

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[1] Op. cit p. 53.

In connexion with spasm of the anus we may notice the effects produced by a preternatural development of the sphincter muscle.

In treating of occlusion of the anus we have referred to the fact, that, at birth, there is sometimes so strong a contraction of this muscle in some infants, as to require the division of its fibres; but that, in others, it may exist in such a mitigated form as to render an operation unnecessary until that period of life has arrived when the fæces become solid.

There is, however, a still further modification of the same condition, which, although it is unattended by the pain which characterizes the former, nevertheless may give rise to morbid consequences. This modification appears to run in families, and depends on the original formation of the subject, the sphincter having in all such cases a preternatural development.

In the early periods of life, while the fæces are fluid or soft, there is but little embarrassment in the function of defecation; but, as they acquire solidity, a mechanical opposition is offered to their egress, and, by the act of absorption, they acquire a hard consistency, and it is only when they are abundant that, by the aid of powerful and long-continued efforts, the sphincter can be relaxed.

As the torpidity of the bowels, induced by such a detention of their contents, increases, the periods of dislodging the fæces become more and more distant from each other, so that a week or even ten days will elapse without visiting the closet; and then, perhaps, the attempt will be made, not from the promptings of nature, but in conformity with a settled plan of the patient's, who is conscious that the act ought to be performed.

It is in such cases that the incautious introduction of a glyster-pipe often does injury by cracking the skin or tearing a hæmorrhoid, exciting thereby so much activity, as to cause it to pass into the severest form of spasm or of spasm with fissure.

It is needless to exhaust our space by dwelling on the plan of treatment which we ought obviously to follow. To diminish the contractility of the sphincter, and to preserve a certain degree of softness of the dejections, are the points to be kept in view; the first of which will be accomplished by a steady, gradual, and periodical introduction of a bougie, smeared with an ointment containing a third of extract of belladonna, if the opposition be very great; and the second by occasional injections of warm water, by a proper selection of articles of diet, especially the substitution of bread made of undressed corn for that in ordinary use, by the exhibition of bark, if the atony of the bowels be great and long-continued, and by enjoining the patient to attempt the act of defecation at the same hour every day.

SPASM WITH FISSURE.

Patients labouring under spasm of the anus in its aggravated form, cannot conceive it possible, and will not believe it if they are told, that an addition could be made to their torments; and it is not until the spasm is complicated with fissure, that they are satisfied of the unwelcome truth.

Perhaps there is no affection in the whole province of surgery which is so much calculated to enlist the sympathy of the beholders in behalf of the sufferer as this, of which Boyer was the first to give a detailed account. It differs from simple spasm in the access of pain taking place when the fæces are discharged, and in there being a greater amount of pain on one side of the anus than in the rest of its contour; but as regards the general phenomena that attend it, it corresponds so entirely with that affection that they cannot well be considered separately.

The attention of surgeons has been directed to the question, whether the spasm be produced by the fissure, or the fissure by the spasm, and the alleged fact that there are numerous cases of spasm observed in which there is no fissure, but none of fissure unattended by spasm, has led the majority to the latter conclusion. The adjudication of this question is of no great practical importance when the disease is established, but if the opinion we entertain be correct, it might tend occasionally to prevent its occurrence.

It is admitted on all hands that spasm without fissure is not uncommon, and this very frequency creates a doubt, that of itself it can be the cause of fissure. That fissure is never observed unaccompanied by spasm is not quite correct, for in syphilitic affections of the anus, chaps or fissures oftentimes exist without exciting the sympathy of the sphincters or being attended with much pain.

There is nothing in the nature of the spasm which, *à priori*, would lead to the inference that it could produce fissure. The action of the muscles is towards, not from, the centre, and there is no tension by their means at any time exerted on the mucous membrane or skin; which, on the contrary, is still more folded, in a manner exactly the reverse of that which we should conceive would originate a fissure.

As, therefore, we can see nothing in the nature of spasm calculated to produce a breach in the mucous membrane, and as we find chaps existing without spasm, we incline to the opinion that they are not at all dependent directly on each other; but that the fissure is an accident occurring during the existence of spasm, and produced, either by the evolution of hardened fæces, or by the forcible introduction of the glyster-pipe.

This view is somewhat corroborated by contrasting the habits of those classes of society among whom the disease is prevalent, with those of people to whom it is nearly a stranger. The custom of washing out the bowels obtains much more extensively on the Continent of Europe than it does in this country, and more in this country than on the Continent of America. In a direct ratio with the prevalence of this custom do we find the disease in question, so that while it is but occasionally met with in England, (and, then not among the mass) it is of common occurrence in France and Italy, but entirely unknown to such of our American brethren as have not witnessed European practice.

It is to be borne in mind, that the habit of glystering is induced by a passive condition of the bowels, and is practised long before the patient comes under the observation of the surgeon, (indeed, most likely before the sphincters have become spasmed) and therefore he has no means of determining the priority of the phenomena; but we are strengthened in our opinion by the fact, that we have never seen or heard of a case of spasm of the anus in which a fissure occurred after it had been submitted to the care of a judicious surgeon.

The situation of the fissure is pointed out by the exquisite pain which prevails above the general suffering, but it is sometimes so superficial and indistinct that the eye cannot detect it. At other times by carefully putting aside the nates, pressing them downwards on each side, whereby all the furrows will be unfolded, and causing the patient to force down the gut, an ulcerated line will be seen, analogous in its appearance to the slit we observe in the winter-lip, and occupying the space between two of the folds which the skin forms as it enters the orifice of the anus. It is generally situated on one side or the other, and rarely to the back, and still more rarely to the fore part of the aperture. Its edges are of a dirty-yellow colour and sometimes slightly thickened; its depth is of a glaring red, and it sometimes extends a considerable distance up the rectum. The agony that is produced by the passage of the fæces over the ulcerated surface is so great as almost to bring on fainting or convulsions, and the mere discharge of wind is so painful and difficult to perform, that in the case of a lady treated by Boyer she had been reduced to the necessity of relieving herself by introducing a gum-elastic tube.

When the expulsion of the fæces is accomplished, there arises the same enduring pain as occurs in cases where fissure is not present; but it is either less in amount, or appears to be so, by the greater pain which precedes it. At all events, the acute, burning sensation which attends defecation, is succeeded by a sickening, bearing-down pain, which extends to the thighs, and which insensibly becomes more and more obtuse, but never entirely vanishes.

In the treatment of cases of this description, we cast aside all consideration of the fissure, and address ourselves to the cure of the affection to which the fissure is merely superadded. There can be no question that the division of the sphincter, on one or both sides, is the surest and readiest mode of placing the parts in a state of repose, and every consideration which would influence us in the treatment of spasm with congestion but without fissure, would be operative in those cases in which it is present. The alternate separation and approximation of its surfaces by the distension of the fæces, and the contraction of the sphincter, is prevented by this operation, and, in the majority of instances, it will be cicatrized long before the severed parts are reunited, if it be not comprehended in the incision. Boyer has described it as being the only mode in which relief can be afforded, and he attaches but little importance to dividing the muscle through the fissure. The object being to unload the congested tissues and to cut the string, as it were, of a tied-up bag, the fissure becomes a matter of subordinate consideration; but, nevertheless, as the same object will be gained by dividing the sphincter at the part where the ulceration exists, it may be, as Velpeau remarks, a point of prudence, if not of necessity, to let the knife act in that direction.

Some difference of opinion exists as to the certainty of success attending this operation. Boyer in the course of a long practice never found it to fail, while, on the other hand, Velpeau states that the same success has not attended it in the hands of others. He himself has witnessed two cases where death ensued after the operation; in one the pelvic viscera adhered to each other, and the cellular tissue was infiltrated with pus; and in the other, purulent deposits were found under the pelvic portion of the peritoneum. It does not, however, follow that the operation was instrumental in producing these effects, nor does it clearly appear that M. Velpeau is of opinion that the avoidance of the operation and the adoption of other means would have been attended with a more happy termination.

Dupuytren has recommended the employment of a plug smeared with an ointment composed of one part of extract of belladonna, one part of diacetate of lead, and six parts of lard, gradually augmenting the size of the plug until it is as large as the fore-finger.

Velpeau reports that M. Dubois was accustomed to maintain that plugs gradually increased in size would constantly succeed; and that, acting on this opinion, he has himself so completely succeeded in two instances as to induce him to recommend the practice.

There can be no doubt that lead and belladonna will be of great service in any case, not however as a cure for the fissure, but in relaxing the muscles; and the application ought always to be made, even if the operation be indispensable, as it is thereby rendered more easy of performance and less distressing to the patient.

We apprehend, however, that this system of plugging is admissible only when the engorged tissues have relieved themselves by the formation of false membranes, in the same manner as takes place in croup, or otherwise, by activity of treatment, been reduced from an acute to a chronic state. Then, indeed, it may be wise to pause before operating, for it is not unlikely that distant parts have been so impressed by the vivid action which has prevailed in the rectum, that positive inflammation might be excited in them by the action set up to reunite the severed structures. But precisely the same reasons which lead us to doubt the applicability of bougies where there is active inflammation *without* fissure, lead us to discountenance a proceeding, which is the same in principle, in similar cases *with* fissure.

It sometimes happens that when the operation has been performed, the pain and prominent symptoms are relieved for a time, and the incision heals kindly until nothing but the original fissure remains, and this obstinately refuses to cicatrize. A train of symptoms similar to, but of a more subdued character than, the former ones, appear, and a second and even third operation may be attended with a like result. In most instances of this kind the indisposition to heal may be attributed to defective general treatment, and more will be done to remove it by a judicious inquiry into the condition of the several portions of the digestive apparatus, and acting on the information so obtained, than by any local treatment; though it is desirable to endeavour to produce at the same time a more healthy surface by the employment of topical means. So long as irritation is absent the ioduret of lead will be found to be serviceable in that, as it is in all other unclean sores; but, when the soft fæces begin to produce pain, the nitrate of silver, or, still better, the potassæ hydras will destroy its irritability and favour the formation of a healthy surface.

CONGENITAL IMPERFECTION.

The congenital imperfections of the anus, which it is sometimes in the power of surgery to rectify, are occlusion and imperforation; and, the probability of being able to render such aid, should impress on all persons engaged in the practice of midwifery, the necessity, not only of examining the infant at its birth to ascertain that there is an aperture, but of repeating the examination on the next and following days, that no doubt may exist that the aperture performs its function.

Occlusion.—On examining the fundament of new-born child, the indication of the anus may, as respects situation and form, be satisfactory; but subsequent events may prove that it is occluded so completely, as to offer as much resistance to the expulsion of the meconium as though it was imperforate; a resistance which, if not overcome, will destroy the child by the accumulation of fæcal matter in the intestines.

The sufferings of the infant, manifested by its cries, hiccough and the swelling of its belly, and the non-expulsion of meconium, render it imperative that the anus be explored. It will then be discovered that the anus is contracted, not only at its verge, but to some distance above it, as though both the external and internal sphincters were in preternatural activity. This occlusion is sometimes so perfect that it is difficult to insinuate a large-sized probe; and in a case we recently witnessed, it was sometime before the small end of a blow-pipe could be introduced, which was no sooner accomplished than the meconium was blown with considerable violence into the face of the explorer; showing thereby, that this affection is dependent on the condition of the sphincters, and not on the mere narrowing of the tube.

This condition of the muscles might, in most cases, be overcome by the employment of bougies, increasing their size according to the success obtained; but the urgency of the case is too great to admit of the adoption of so tardy a mode of relief, especially when, by a simple operation, the obstacle may be speedily overcome.

A conductor being introduced, a bistoury should be carried in its groove to the distance of about an inch; and then drawing the handle outwards, so that the extremity of the blade may press in the groove of the conductor, it should be drawn obliquely downwards and outwards, towards the tuberosity of the ischium, in such a way, that the lower part of the incision may extend about a quarter of an inch from the anus. The same plan should be pursued on the opposite side, and the incised parts dressed with spread lint.

Great stress is laid by some authorities on keeping a plug in the anus, to prevent the reunion of the sides of the wound. This might be of some service if the incisions were so slight as only to serve for present exigencies; as then the remainder of the cure must be effected by dilatation. But when the operation has been properly performed, there is no occasion for a plug, inasmuch, as the cut having passed across the direction of the muscular fibres, they will retract and drag the faces of the incision away from each other, so that if the object were to reunite them it would be difficult to accomplish it.

There is a modification of this occlusion in which, by its not being so complete, the meconium and fluid fæces during infancy are permitted to pass; and it is not until such time as the dejections acquire a certain consistency that the imperfection is discovered. Even the entire period of childhood may be passed without very aggravated suffering; but when the age of adolescence arrives, the pain attending the dejection of the fæces is intolerable, and that in proportion to their solidity. As in the former instance, immediate relief is afforded by cutting across some of the fibres in the manner previously described.

Imperforation.—The congenital defects of the rectum which might be ranged under this head are various. The intestine may be entirely wanting, and its place supplied by fatty cellular tissue, the colon above it ending in a pouch: it may terminate in the bladder of the male, or the vagina of the female child: it may be perfect but blocked up by the integument; and, in all these cases, there is no external appearance of the anus.

The intestine may degenerate into a cord, and at the lower part, re-assume its cylindrical shape, thus forming a pouch towards the anus; it may be interrupted in its course by a thickening of its coats, its sides approximating as though it were tied with a tape; or it may be interrupted by a membranous or a rigid septum, the diameter of the canal at that part not being diminished; and, in these cases, the anus appears to be perfect.

The intestine and the anus may be perfect, but, by the extension of the skin from one side to the other, the aperture may be wanting.

Anus closed by the skin.—A careful accoucheur would discover this defect at the time of birth, and by a timely and trifling operation, save the child the suffering it must undergo by delay.

The anus appears, on a superficial examination, to be formed naturally; there are the corrugated line and the plicated radii passing from it; but on separating the nates a pale blue line is observed, its colour being produced by the meconium above it; and, pressing with the finger, a cavity is readily detected beyond it.

This skin or membrane sometimes is not attached to the anterior part of the margin of the anus, but advances forwards on the perineum, forming a short canal through which the meconium may be squeezed in drops.

Slitting this membrane with a sharp pointed instrument, and taking hold of the divided portions with a pair of forceps, that they may be cut away from their attachments with a pair of scissors, is all that is to be done in an operation which can never fail when it is timely performed.

Anus closed by integument.—In this defect the usual signs of the anus are wanting, and the surgeon will have to guard his reputation by not too confidently prognosticating the favourable issue of an operation. It may be a case in which there is no rectum, or, if one exist, in which it opens into the bladder or vagina, according as it may be a male or female child; though that fact would soon be set at rest by the transmission of meconium from the organ.

As so much uncertainty prevails, it is necessary to be guarded, both in our opinion and practice; for if it should turn out that there is no rectum, or that it terminates midway in a pouch, it will be only remediable by a proceeding, to be hereafter described.

But there are sometimes grounds sufficient to justify a favourable or an unfavourable prognosis. If the integuments on the part where the anus should be, be a plane even surface, and, more especially, if it should bulge downwards from the os coccygis—if one buttock should insensibly glide into the other by an undulating surface,—if there be no attempt at a corrugation of the skin, and if a sensation of solidity be communicated to the touch, it is highly probable that the rectum terminates at some distance within the pelvis: but if, on the other hand, there shall be a fair cleft between the buttocks; if the integuments be well drawn up so as to form a sulcated line (bearing in mind that in well-formed children it is less marked than in the adult); if there be any appearance of an attempt to establish folds of the skin; and, more than all the rest, if a digital examination (that *tactus eruditus* which may be conceived but cannot be expressed) should satisfy the surgeon of the existence of a cavity, the presumption is, that the rectum will be found at no great distance within the pelvis.

The operation consists in making a crucial incision through the integuments (the flaps of which should be turned aside) and in carefully pursuing the dissection in the direction of the rectum. The finger should be introduced into the wound after each application of the knife, with a view to ascertain the situation of the gut. This may be ascertained immediately after the operation has commenced, when the gut is near, for the rectum is sure to be distended with meconium, and, therefore, easy to be appreciated by the touch.

Whether the surgeon will pause when he has unsuccessfully attained the situation where the sphincters ought to be, or whether he will continue his dissection in the direction of the sacrum, as he may be encouraged to do from the success obtained by others, will be a question for his own judgment to determine; but this rule ought always to be abided by, never to plunge a trochar, or any other piercing instrument, at hazard, but always to use the knife, carefully exploring the way until the distended rectum can be felt.

Anus perfect, but the canal interrupted.—Here, again, it may be an affection of a very serious character, or one remediable by the means already described. An examination with the little finger will furnish reasons for presuming it to be one or the other.

When the obstruction is caused by a membranous septum, it will project by reason of the meconium accumulated above it pressing it downwards, but it will recede when the child cries. If the nail be rather long, it will readily rupture it by working against it in the intervals of the fits of crying; or a pair of short-bladed scissors may be introduced along the finger, their points passed through the membrane, their handles gently separated, and the membrane may thus be sufficiently torn for the immediate purposes of the child. It will be necessary to introduce daily a bougie, increasing the size until one of half an inch diameter will readily pass up the gut.

In those cases where the top of the pouch is pursed, and has a thickened feel, leading us to suppose that they depend on a thickening of the coats at that part, the only means of relief will be by introducing the canula of a trochar, and, holding it fixed against the point of opposition, to force the stiletto through it. There is more uncertainty in the result of this operation than there ought to be in any act connected with science; but it is an uncertainty, which, as we cannot free ourselves from without, perhaps, sacrificing a life that might be saved, we must not hesitate to risk.

As in the former species of obstructions, so in this, bougies must be introduced, and suffered to remain in the aperture; not, however, with the same view (which, in that instance, was to dilate the opening in the membrane) but to stimulate the vessels to absorb the effused lymph which always attends, though it may not entirely produce, this form of obstruction. The introduction of bougies must, therefore, be more protracted, and their size more cautiously increased, to carry out the end we propose to ourselves.

When the gut tapers to a point, and the finger can recognize nothing through its parietes, or when the whole of the space which the gut should naturally occupy is filled up with cellular tissue, it will prove to be one of those unhappy cases in which the rectum above is degenerated into a solid cord, or terminated in a *cul de sac*, and in which the experience of MM. Roux de Brignolles and Amussat may lead us to hope for better results than we have yet dared to look for.

It has been generally supposed hitherto that cases in which the lower part of the rectum is wanting for one and a half or two inches, as well as in those in which the intestine communicates with the bladder, vagina, or male urethra, by an opening insufficient for the discharge of the fæces, must of necessity terminate fatally. Such, indeed, has been the opinion of the most eminent surgeons, for the opening of the abdomen above the iliac fossa, or the blind plunge with the trochar in the perineum, afforded too slender a chance to be accounted for any thing. On this point of surgical practice, nevertheless, a very decided improvement has been achieved, and the pale of art has been enlarged, so as to admit for remedy those cases which, being deemed beyond its resources, were until lately abandoned to their unhappy fate. The imperforation of the anus in which there is nothing to indicate the vicinity of the rectum, is unquestionably one of the most embarrassing occurrences in surgery, whether we regard the fragility of the subjects, or the gravity of the operations necessary for their relief; but the evil is not desperate. We lay before the reader an abridged account of two cases of imperforation of the anus, treated successfully by operation, which show that we should not despair, even under the most unfavourable circumstances, of correcting these malformations by a decided, but cautious, method of proceeding.

The case of M. Roux de Brignolles, was one of imperforation both of the anus and urethra. The labour having been superintended by an ignorant midwife, the infant had been left nearly two days without succour. M. Deveze, a neighbouring practitioner, having been called in, he soon ascertained the existence of the imperforations. The urethra was closed by a thin membrane at the base of the glans, constituting a sort of hypospadias. The penis being swollen and erect, this membrane was perforated with a stilette at once, and the urine was voided.

Two days had elapsed before the consultation was held; the countenance of the infant exhibited signs of deep suffering, the skin was yellow and dry, the abdomen tympanitic and painful, and the convolutions of the intestines could be distinctly traced upon its surface; there was frequent hiccough, with vomiting of the milk and sugared water that had been given. When the infant cried, there was neither movement nor prominence in the region of the anus, from which the proximity of the rectum might have been inferred; nor could any indication be obtained by exploring with the finger. Here was obviously one of those unhappy cases, of which so unfavourable a prognosis has been given by Petit, Boyer, and many of the most eminent surgeons, viz. that *in which there is no trace of opening, the anus being closed up by the skin, which is hard and thickened*, and for which an operation in the region of the anus is, at first, no better than an exploration. M. Roux, however, was resolved to hazard an attempt to save the child's life, and performed the operation for opening the rectum in the following manner:—

The little patient having been placed on the lap of an assistant, in the same manner as for the operation of lithotomy, an incision was made in the skin, about an inch in length, in the exact line of the raphé, which could not be seen in the perineum. On separating the lips of the wound, the fibres of the elliptic muscles of the sphincter could be seen; their internal borders were in contact, and presented a straight line, but they contracted in a circle and with considerable force, when the infant cried. The incision was continued through the levatores ani muscles, to the depth of an inch, the edge of the knife being directed backwards towards the coccyx. The incision at this depth terminated in a mass of cellular tissue. So far, the dissection was made with a scalpel; a straight bistoury was now directed into the interior of the pelvis, the point being turned obliquely upwards and backwards, in order to avoid the bladder. It soon entered a cavity, which was supposed to be the rectum; the handle was then raised, and the blade withdrawn in this position for the purpose of enlarging the internal incision. The meconium, which now came slowly forth, announced the success of the operation.

Abundant injections of marsh-mallows water were now thrown up, to wash out the intestines as quickly as possible. The first phalanx of the index finger reached to the bottom of the wound, which was dressed with a thick mesh of charpie smeared with ointment.

This mode of dressing was kept up for fifteen days; after this period, granulations began to sprout from the edges of the wound, impeding the progress of the fecal matter, producing colic pains, and giving rise to another remarkable phænomenon.

As soon as the anal opening began to be obstructed, the stools became less frequent, and more difficult, and the urine which was voided, pure and limpid, was followed by a small quantity of excrementitial matter. The wound having been enlarged towards the coccyx, the bowels were again easily relieved, and for some days the urine alone was voided by the urethra. But again the granulations springing up, and obstructing the anus, the fæcal matter was observed to be passed, though in small quantity, after the urine. These were checked by the application of nitrate of silver, and the artificial anus having been kept open by the introduction of large-sized bougies, till its cicatrization with sufficient dimensions was completed, fæcal matter was no longer observed to come by the urethra. The border of the anus itself, after a little time assumed the plicated appearance of the natural outlet.

M. Roux blames the mode adopted by other surgeons in treating those cases, by puncture with a bistoury, lancet, or trochar, as hazardous; whilst, on the other hand, by a slow and methodical dissection of the muscles of the perineum and anus in the median line, the surgeon readily ascertains his chances of success, for as soon as he has passed the elliptical muscles of the sphincter, and the levatores ani, he enters upon the cellular tissue, in which the finger will enable him to detect the intestine. There can be no doubt that the finger is by far a better exploring instrument than a probe or sound. It is possible, however, (although the case must be extremely rare,) that the rectum may be entirely wanting, and, in such a case, the only chance of saving life would be, to cut into the sigmoid flexure of the colon, as successfully performed by Duret of Brest, thus establishing an artificial anus above the iliac region.

M. Roux' theory as to the formation of the rectum, is the same as that of M. M. Serres and Geoffroy St. Hilaire, who account for the atrophy or absence of the organs generally, by the deviation or absence of their nutrient arteries. The arteries of the rectum are derived from the inferior mesenteric, the hypogastric and the pudic; collectively they are called *hæmorrhoidal*, being distinguished into the superior, middle, and inferior; but their origin being different, they are very rarely all absent in the same individual, and hence a well-grounded hope may be entertained, when the inferior extremity of the gut is wanting, that it will be found higher up, in front of the sacrum. In M. Roux' case, the imperforation, as in most of those cases, was attributable to the deviation, or diminution in calibre of the branch of the pudic, which is, in reality, the *formative* artery of the inferior extremity of the rectum; and hence it happens that imperforations of the anus are often accompanied by malformation of the sexual organs. The passage of fæcal matter, which, it will be remembered, was voided by the urethra, when the artificial anus was obstructed by granulations, is explained by M. Roux, by supposing that a sort of urachus, provided to remedy the obliteration of the natural outlet, and formed by the deviation of the inferior hæmorrhoidal artery, a branch of the pudic which supplies the penis, was prolonged anteriorly from the blind extremity of the rectum into the urethra. From this deviation or absence of the arterial branches, where the rectum is wanting, he also accounts for the little blood shed in the operation, not amounting to a tea-spoonful.

M. Roux thinks that the elliptic muscles of the sphincter and levatores ani, which receive their nutrient arteries from the ischiatic, are never wanting; and hence, that their utility in the act of defecation, should not only be calculated upon, but secured, by conducting the dissection in such a manner as to free their internal border: the artificial anus being thus established in the line, by which they are naturally separated, their liberty of action is preserved.

Fig. 106.

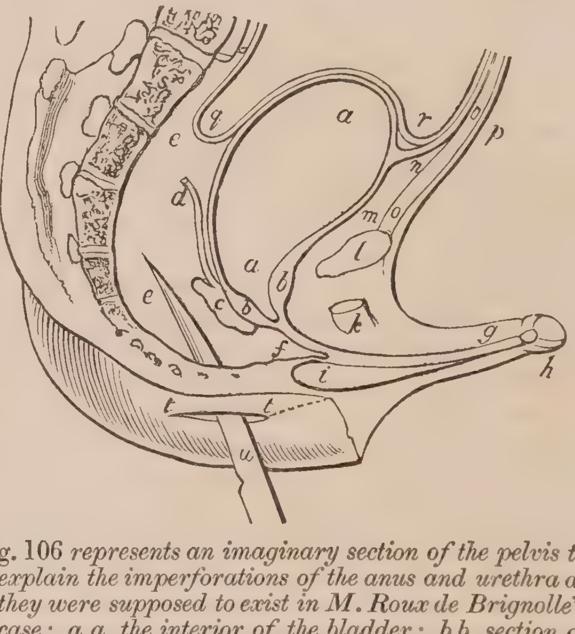

Fig. 106 *represents an imaginary section of the pelvis to explain the imperforations of the anus and urethra as they were supposed to exist in M. Roux de Brignolle's case: a a, the interior of the bladder; b b, section of the prostate; c, the vesicula seminales; d, the vas deferens; e e, the interior of the rectum; f, supposed termination of the rectum in front of the neck of the bladder; g, the penis; h, the opening of the meatus; i, bulb of the urethra; k, root of the right corpus cavernosum; l, section of the pubis; m, space between the pubis and bladder; n, the urachus; o, the muscles of the abdomen; p, the skin; q, r, the peritoneum lining the cavity of the abdomen; s s, sacrum; t t, the incision in the perineum; u, the bistoury, its point in the rectum.*

This operation, performed 15th May, 1833, was soon followed by another, with an equally successful result. M. Amussat, whose case it was, thus describes it in a communication to the Academy of Sciences.

Mrs. B., an English lady residing in Paris, gave birth, on the 6th September, 1835, to a female child. The external parts being well-formed, the real nature of the case was not suspected at first. M. Deneux, who attended the lady, in a note to M. Amussat, requesting his assistance, describes the case as "*one of occlusion of the large intestines in a new-born infant; the anus being well formed: the rectum communicates with the vagina, and the obstacle appears to be situated high up.*"

M. Amussat did not see the infant till thirty-four hours after its birth. No meconium had been voided, and the nurse stated that the tepid water injected into the anus, returned by the vulva. The child seemed strong, and well proportioned. The abdomen was hard, and swollen. The anus and vulva were, to all appearance, natural. A flexible canula introduced into the anus penetrated to the depth of two inches, and the water injected through it, came out immediately by the vulva. A sound, introduced by the vulva into the vagina, struck the canula previously introduced into the anus.

"We were of opinion," says M. Amussat, "that the rectum was obturated at the depth of about two inches, and that it communicated with the vagina; that there existed a species of recto-vaginal fistula, or, in other words, that the septum by which the rectum and vagina are parted, was deficient to a considerable extent.

"On communicating to the parents that an issue could only be obtained, either by the anus, or by the abdomen, and exposing the dangers and inconveniences attaching to both these operations respectively, they preferred, decidedly, that the attempt should be made to make an opening by the natural route, rather than through the abdomen, although we declared to them at the time, that this plan, even if successful, would of necessity leave a communication between the rectum and vagina. It was accordingly decided, that an attempt should be made to discover the interrupted intestine.

"With this view, I proposed dilating the anus with prepared sponge. At four o'clock in the morning, a bit of sponge an inch and a half long, but somewhat smaller than the little finger, was introduced into the anus, and supported by a T bandage. This piece was to be removed at eight o'clock, and another somewhat larger introduced, to remain till twelve, at which hour it was agreed that an operation should be performed, if necessary.

"At eight o'clock, the sponge was withdrawn, it having dilated the anus to such an extent, that I was enabled to introduce the little finger, making it come out again at the vulva; but higher up it was stopped, as if it had been in a *cul de sac*. During this exploration, the urine was voided in considerable quantity. Another sponge tent, longer and thicker than the first, was now introduced."

At twelve o'clock, when the consultants, M. M. Deneux, Lebaudy, and Amussat met again, the anus was so much dilated as to permit the introduction of the little finger with ease; the *cul de sac* and the communication were again recognized. An examination was now made, in order to discover the rectum distended by meconium, and to perforate it.

"We were still persuaded that, in doing this, a recto-vaginal fistula was unavoidable. However, in again exploring with the index finger, I discovered at the upper and front part of the cavity, a sort of fungous narrowing, which I at first mistook for the narrowed or obturated point of the intestine. Above and behind, the soft bag, which I imagined to be formed by the rectum, could also be felt. In describing what I felt, I stated that it communicated the same sensation as if I was touching the effaced and soft neck of a uterus. Each of us having examined in turn, M. Deneux thought that it was in reality the neck of the uterus, and such it proved to be."

The case, as now established, turned out to be this: the anus, without rectum, opened into the vagina, in which the vulva and anus communicated with each other: and thus there were, strange to say, two openings in the perineum, instead of one, both terminating in the vagina.

"On thus discovering, that I had to deal with an extraordinary malformation, consisting in the absence of the rectum or a part of the rectum, I determined to explore carefully, the entire pelvis, through the walls of the vagina. In feeling with the end of the finger, to the left of the sacro-vertebral angle, through the posterior wall of the vagina, I detected a flattened body, which yielded under the finger. On repeating the examination several times, the sensation was always the same. Reflecting on this circumstance, I became satisfied that what I touched must be the rectum; my colleagues were of the same opinion. The obscurity which hung over the case was now completely dispelled; it was evident that the vagina alone occupied the cavity of the pelvis, and that the extremity of the imperforate rectum was situated above, behind, and to the left of the sacro-vertebral angle. I now felt, in a manner, relieved from the difficulty which the operative proceeding must present, in so delicate a case, and resolved at once to reduce to practice, the operation which I had long thought of for similar cases.

"Before commencing the operation, we again satisfied ourselves, that the membranous body which we felt, was the termination of the rectum, placed at the height of about two inches from the skin of the perineum.

"The plan I intended to adopt had been suggested to me by my failure in two other cases, on which I had operated, in conjunction with my friend, Dr. Roussel, and in which the imperforate rectum terminated at the distance of one and a half to two inches from the skin of the perineum. In both of these cases, I had made the incision at the place where the anus ought to have been; dilated the wound with prepared sponge, and, in fine, perforated the rectum distended with meconium. The infants became yellow, and died in a few days. I attributed the unsuccessful results to the resorption of bile and meconium, as they passed along the bleeding cellular surface of the artificial opening. Being averse to Littre's operation, I was still of opinion that it would be better to restore the natural passage, if the danger arising from the resorption of these fluids could at the same time be guarded against, and this I thought might be effected by drawing the intestine down to the external opening, and then fixing it by points of suture. Experiments on the formation of artificial anus in animals, had convinced me, that, by this means alone, the evils of resorption, infiltration, or stercoral abscess were to be with certainty avoided.

" A proposition so extraordinary was not adopted at once. My fellow-consultants made many objections, chiefly on the score of hæmorrhage, abscesses, &c., which were fairly discussed; and it was not until I had fully developed every step of the plan I meant to execute, that I could obtain their consent. These steps were as follows: to make an opening in front of the coccyx, behind the vaginal anus, to detach with the finger, and with the bistouri the posterior paries of the vagina, from the coccyx and sacrum; to ascend thus to the *cul de sac* formed by the rectum, and, after recognizing it both by the vagina and by the new passage, to lay hold of it with a pair of erines; to detach it all round more with the finger, than with the bistoury; to draw it down to the opening in the integument, open it largely, and, after allowing the meconium to flow, to connect, in a secure manner, the opening of the intestine with that of the skin."

" The state of the case being once more submitted to the parents, and having now announced to them, that if the operation proved successful, there would be no recto-vaginal fistula, we found them resigned to the bold operation we were about to perform.

" The infant in the mean time had been placed in an emollient bath, in order to calm the irritation produced by our explorations, and by this means, was still better disposed for the proceeding.

" Every thing being now ready, the infant was placed on a table, in the same position as for lithotomy. A transverse incision of about eight lines in extent, was made just behind the vaginal anus, with a short-bladed bistoury, convex on its edge; another incision directed towards the coccyx, gave the form of a T to the opening by which my finger was introduced, to make a passage between the vagina on the one hand, and coccyx and sacrum on the other, having previously placed a sound in the vaginal anus, to serve as a guide, to protect its posterior wall from injury. I partly cut and partly tore the cellular tissue uniting these parts. Proceeding in this way, I penetrated till I discovered the end of the rectum. at the depth of two inches. From the instinctive efforts of the child, we were all much better able now to recognize, through the vagina, the sort of pouch formed by the rectum. I now seized it with a double erine, and drawing downwards, I disengaged the intestine from the slight adhesions by which it was on all sides surrounded, except on that of the vagina, where I was obliged to make a cautious use of the bistoury. The extremity of the rectum soon became visible within the wound, and, to our great satisfaction, we saw the meconium oozing out at the punctures made by the crooks of the erine. Having passed a needle and thread through the end of the intestine, it was brought down to the level of the integuments. A large opening was now made, from which issued a quantity of meconium and flatus. The operation was terminated in the following manner:—traction having been kept up by means of forceps, until the lips of the wound in the intestine were drawn beyond the opening in the skin, I attached them by three points of suture at each of the angles of the wound; but these being found insufficient to prevent the intestine from ascending, six or eight points more were made all round its circumference.

Fig. 107.

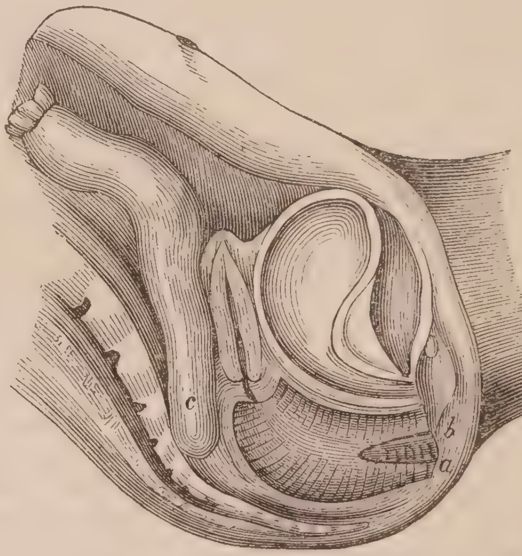

Fig. 107. *In order to render the details of this operation intelligible, M. Amussat has given a plan of the parts as he supposed them to exist before the operation. He took pains to make the analogy as complete as possible, by taking his sketch from a left-side view of the interior of the pelvis in a female child who died a few days after birth. All the organs in the pelvis had been cut in two, part of the rectum was removed, to represent the deficient portion of the intestine, and the anus was made to communicate with the vagina. a and b represent the anus and vulva, which were properly formed, and communicated with the vagina only. c, the extremity of the rectum forming a* cul de sac *below the sacro-vertebral angle, and having no communication with either the anus or vagina.*

" There was but little blood lost; injections were thrown up to empty the bowels; the child was placed in a hip-bath, and poultices were applied. She soon recovered her strength and warmth, on being placed beside the mother. No fever followed the operation.

"After a lapse of twelve days, the anus showing a disposition to become narrow, it was necessary to have recourse to the introduction of meshes smeared with tallow, for which gum elastic bougies were substituted after a few days."

These two cases are of the highest interest, and present a point of comparison, upon which it may be useful to dwell for a moment. In M. Roux' case, the patient was a male, and the rectum was opened at the point where it was found within the pelvis. The inconvenience and suffering resulting from the growth of granulations along the track of the wound, was severely felt, and might have compromised the ultimate success of the operation. M. Amussat having observed, in two cases in which he had previously failed, that his want of success was attributable to the resorption of bile, infiltration, and the formation of abscesses along the artificial opening, supposes, and apparently upon strong grounds, that the fatal termination which almost always takes place in a short time, when the rectum has been opened with a trochar, bistoury, or lancet, may be accounted for by the want of protection which a mucous surface would afford to the new passage. He relies for his conclusion, it is true, only on one case, but, as he very justly remarks, "This case is not to be regarded merely as an additional testimony in favour of the power of surgery; the success of the operation is a point of inferior interest, when compared with the possibility of doing in almost every case, that which, before this operation had been performed, we had no idea might be done; in a word, the important point, was to show that we could accomplish through the natural passage, that which Littre had proposed to do through the parietes of the abdomen, and which A. Dubois, Descaux, Duret, and others had executed."

M. Amussat reduces the various malformations of the anus to five species, which he classifies thus :—

In the first the anus is preternaturally narrowed ; in the second, the anus is closed up by membrane ; in the third, the rectum is intercepted by a simple septum, at a variable distance from the anal opening ; in the fourth, the anus is imperforate, and the rectum is deficient to a greater or less extent. This is the most numerous class of these malformations, and comprises the case above described, as the vaginal anus may be regarded merely as a superfluous opening. In the fifth, the rectum opens into some other organ, as the bladder, urethra, and vagina, or at some point of the pelvis or sacrum. Each of these species, he advises should be treated as follows : in the first, an incision of the anus should be made, and the opening dilated ; in the second an opening should be made in the centre of the membrane, which should be excised all round as high as the sphincter, and the opening maintained by means of tents or meshes ; in the third, after dilating, or slitting the anus at its back part, and on its side, the mucous membrane should be detached and the rectum drawn down, the inferior portion is then cut off, above the septum, and the gut is sutured either to the sphincter, or what is still better, to the skin. M. Amussat thinks himself justified in proposing this operation, on the ground that in the cases where the septum has been only punctured, the children have died ; in the fourth, M. Amussat's example is the best that can be followed. It may, however, be observed that although he deserves the highest praise for the great skill and judgment displayed in the planning and performance of this interesting operation, the surgeon, in any similar undertaking should not overlook the very great importance of utilizing the sphincters wherever it is practicable. The external incisions should therefore be so conducted, that the rectum when drawn down, shall be in its natural situation between them, for thus only can the complete function of the anus be established. In the fifth, he is also of opinion that the same process may be adopted, unless the abnormal anus performs its functions satisfactorily. But when the intestine opens into the bladder or the urethra, the posterior wall only should be drawn down, because if the opening could not be closed an extravasation of urine might ensue.

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(*John Malyn.*)

ANUS, ARTIFICIAL. This term is often confounded with Anus, Preternatural. Strictly speaking, the artificial anus can only be formed by the express intervention of the surgeon; as in the cases described in the preceding article, or when, in the operation for relieving an incarcerated portion of intestine, he discovers that the bowel has sustained too much injury to be safely returned. Under the latter circumstances, he may prefer making an opening into the intestine itself, and in this sense also the anus is said to be artificial. But it may be also formed accidentally, as in wounds of the abdomen, or when the intestine has given way spontaneously, and adhesions are formed to the abdominal walls, all round the opening. As both these terms are inaccurate, we shall refer the reader to the article Fistula, Intestinal.

AORTA, (See Arteries, Diseases of).

APHERESIS, or APHÆRESIS, (ἀπὸ, 'from,' and αἵρεσις, 'taking away.') Hippocrates employed this word to designate the removal of a part of the body; in a more precise sense, it has been applied to the removal of parts by operation, or to that department of surgery which treats of such operations. It also represents the opposite or counter-sense of the term 'Prothesis.'

APONEUROSIS, from ἀπὸ, 'from,' and νεῦρον, 'nerve;' the ancients imagining these webs to be expansions of the nerves. *Aponevrose*, Fr. Flesche, Ger. This name is given to a class of inextensible membranes, of a bright silvery hue, and fibrous texture. Aponeuroses present various degrees of density, being in many places as fine as the cellular tissue itself; whilst in others it seems to pass into tendinous expansions, or strong fibrous bands, which may be considered as extensions of the osseous skeleton. They form an envelope for the entire body, and are therefore co-extensive with the external integument, with which they are connected by numberless prolongations: they also envelope the muscles, sending prolongations between their fibres, and even sometimes forming complete interruptions in the course of their length. Although the term has received so extensive a signification in common language, a difference is recognized; the general attenuated webs lying beneath the skin, as well as in other situations, being called *fasciæ*, while the denser flat webs which envelope some of the powerful muscles, and furnish them with attachments to bones, are distinctively called *aponeuroses*. They present a vast number of septa, forming, as it were, chambers for the muscles; thus isolating them completely from each other, and maintaining them in their proper situations, while they also support them in their contractions, or moderate their violence. In some situations they are provided with tensors, as in the upper and outer part of the thigh; in others, they are cushioned on fat, to moderate their tension, as in the palmar and plantar fasciæ. Much, therefore, of the power of the muscles, and of their uniformity in action, depends on these fibrous envelopes; the great vessels and nerves are also indebted to them for protection, while the venous and lymphatic circulation is assisted by the constriction, which they exercise under certain circumstances.

Strong and unyielding, in inflammations of the cellular tissue beneath them, their resistance is the cause of the excessive tension, and long confinement of the pus, so common in parts where they are strong and numerous, The surgeon should therefore be well acquainted with the situations of the various aponeuroses, in order to be able to act with judgment, promptitude, and effect, in liberating matter when once formed, which otherwise would remain pent up, disorganizing the fibrous sheaths which opposed its progress towards the surface, or burrowing through and separating important parts in search of an outlet, and affecting, seriously and permanently, the usefulness of muscles, tendons, &c. When no issue is afforded, the vitality of these expansions being low, they soften and die, becoming riddled with holes, or sloughing more or less extensively. The same observations will of course apply to extravasations of whatever kind they may be. When these fluids are left to find distant openings by circuitous routes, scattered abscesses and fistulous tracks are formed, which will require numerous counter openings.

When suddenly and forcibly stretched, they are liable to be torn, like the tendons, but if the extension be induced slowly, they grow thin and fray, allowing herniæ of their contents; when once in this state, their want of elasticity prevents their perfect recovery. Eventrations of this description occur from Ascites and Pregnancy. The author of this article saw the displacement of the biceps humeri arise from this cause.

APOSTASIS, (ἀπὸ, and ἵστημι, 'I stop.')

A collection of pus formed at a distance from its source; an abscess by congestion.

APPARATUS, *appareil*, Fr. The general term apparatus designates the assemblage of all those implements and objects required by the surgeon in the execution of operations, as well as in the application of bandages and dressings.

Besides the instruments suited to particular operations, which are generally arranged beforehand, and disposed in cases, very many articles, the necessity for which is common to all operations, must be prepared on the spur of the moment; and a skilful surgeon will not confine himself to what is absolutely necessary, but will endeavour to foresee every possible emergency, so as never to be at a loss or delayed, during the progress of an operation. We shall, therefore, in the first place, take a survey of those general preparations on which the success in some cases, and, in all, the prompt and dexterous performance of surgical operations so much depend.

Although such matters are generally left to the assistants, the operator must not neglect to satisfy himself that warm and cold water, sponges, and towels, are in readiness; that bandages, compresses, adhesive plaster, lint, and other dressings, are previously prepared and arranged; that tourniquets, scalpels of various forms and sizes, tenacula, and the usual contents of the pocket-case are at hand; and, finally, a small tea-pot, containing wine or other restoratives, should never be forgotten.

The apparatus furnished by the surgical instrument-maker, is arranged in sets according to the particular operation; thus we have cases of instruments expressly for trepanation, amputation, lithotomy, hernia, paracentesis, cataract, &c., the contents of which will be specified in the articles on those subjects. The pocket-case for general purposes ought to be provided with instruments for the most common and simple operations, as well as those necessary for conducting dressings; these consist of a double-edged scalpel, straight and curved bistouris, (those made to close with a clasp are the most convenient) scissors, a spatula, dressing and ligature forceps, tenacula, directors, probes, a caustic case, needles and ligature-silk; a female catheter, convertible into one suited to the male urethra, by screwing to its open extremity a straight canula adapted to the purpose, is a frequent and useful addition.

It is the duty, further, of the surgeon to ascertain that each instrument is in its proper condition, and, when disposed in the order required by the stages of the operation, to take care that a cloth be thrown over the whole, to conceal them from the eyes of the patient, a precaution which, notwithstanding the reproach of our continental brethren, is not always sufficiently attended to.

(*Henry T. Chapman.*)

APPARATUS, MINOR, MAJOR, and **ALTUS**, are names bestowed upon three modes of operating for the removal of stone in the bladder. (See LITHOTOMY.)

AQUEOUS HUMOUR. The aqueous humour is the small quantity of clear transparent fluid situated within the chambers of the eye[1]. It is secreted by a delicate membrane which lines the cornea,—is thence reflected upon the corneal and neural surfaces of the iris, and finally passes over, and is most intimately associated with the anterior capsule of the lens. This beautifully delicate membrane is divided by anatomists into three portions, named from the parts upon which they pass,—*corneal*, *iridal*, and *capsular*.

The aqueous humour is somewhat turbid, and of a reddish colour for about a month after birth, in consequence of the rupture of the pupillary membrane, which very generally takes place when extra-uterine existence commences[2]. In a healthy state of the eye, the clearness and transparency of the aqueous fluid continue until a very advanced age, when it has usually a cloudy, whitish appearance. When the aqueous fluid is discharged, it is very rapidly regenerated. It possesses powerfully solvent properties, so that when minute fragments of metal and other hard substances are forced into the anterior chamber, they are gradually dissolved by it; not, however, always; for on several occasions I have observed that such substances have acquired a delicate cyst, and have remained for years without exciting much irritation. There are forms of disease in which the aqueous fluid is much increased (CONICAL CORNEA, HYDROPHTHALMIA), and there are also morbid conditions, in which it is generally found to be diminished (ATROPHIA BULBI, SYNECHIA ANTERIOR).

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[1] The variations in the quantity, colour, &c. of the aqueous humour, at different periods of life, are minutely explained by Burrhy (De Artificio Oculorum Humores restituendi. 1669). Fabricius ab Aquapendente (Opera omnia Anatomica et Physiologica. 1687). Nuck (Tractatus de Ductibus Oculorum Aquosis. 1695). Hovius (Tractatus de Circulari Motu in Oculis. 1716). Petit (Mémoires de l'Académie Royale des Sciences de Paris. 1728). Zinn (Descriptio Anatomica Oculi Humani Iconibus Illustrata. 1755). Haller (Elementa Physiologiæ Humani Corporis. 1763). Porterfield (A Treatise on the Eye, the Manner and Phenomena of Vision. 1769). Wardrop (The Morbid Anatomy of the Human Eye. 1808). Clemens (Dissertatio sistens Tunicæ Corneæ et Humoris Aquei Monographiam Physiologico-pathologicam. 1816). Dalrymple (The Anatomy of the Human Eye. 1834).

[2] I am not aware that this has been previously mentioned as the cause of the red appearance the aqueous fluid assumes at the period of, and for a short time after, birth; but I have not ventured the opinion without adopting every means which occurred to me of ascertaining its accuracy. I am not now referring to that mere reddish appearance of the pupil, observed for several weeks after birth, and which is occasioned by the light brown colour of the choroid pigment, but to an actual redness of the aqueous fluid itself, which, however, is not noticed in those cases in which the pupillary membrane disappears by the cessation of its circulation, and the absorption of its wasted texture and vessels.

The characters of the aqueous humour become changed during the progress of various diseases, and many anomalous examples are recorded, in which the chambers of the eye have suddenly assumed a milky or a florid appearance, which has continued for a short period, and then disappeared with marvellous rapidity. In these cases, the individuals have generally suffered from periodical amaurosis, or some form of intermittent blindness[1].

A sudden effusion of blood into the chambers of the eye may result from local injury, from excessive exertion, coughing, vomiting, straining, a severe fall or blow, great plethora, or any undue excitement, and is indicated, when existing as the only appreciable defect of the eye, by pain, tension of the globe, impaired or lost vision, and, probably, also by great uneasiness in the head. In all such cases, the means of cure involve the adoption of the necessary measures for the prevention of local inflammation, or for its suppression, if it be present; with a due attention to the removal of general vascular fulness, if it exist. If the effusion of blood be considerable, the whole of the anterior chamber will have a dark red appearance, and the iris will not be visible; but it more commonly happens that a small quantity only is effused, which sinks to the bottom of the anterior chamber,—its upper margin being of a pale, and its lower border of a deep red colour, and of considerable consistence. This is not suddenly, but gradually absorbed. Walther and others refer to examples of this nature, in which the effused blood was small in quantity and disappeared almost instantaneously, so that I am induced to suppose it ceased to be visible by passing behind the iris, and was absorbed in that situation. Effusion of blood into the chambers of the eye has been said to occur periodically in a few instances, and to be vicarious of menstruation. No case precisely of this description has fallen under my observation; but I have met with two instances in which the aqueous humour has gradually assumed a faint pink appearance, without any distinguishable inflammation of the eye. In both these cases (which occurred in young women suffering from a temporary suspension of the catamenial discharge,) the part became clear and healthy under the use of simple local applications, and the disease has not recurred. Fungoid growths and abscesses of the iris sometimes occasion a sudden effusion of blood into the anterior chamber, but, in all such instances, the source of the hæmorrhage is sufficiently manifest. When a sudden and considerable effusion of blood takes place into the chambers of the eye, in a plethoric person, independently of any clearly ascertained cause, as respects the organ of vision, it is advisable to recommend the patient to be freely bled, and to go through a course of proper depleting treatment. When the effused blood exists in considerable quantity, —when a dense clot has sunk to the bottom of the anterior chamber, when the absorbent process proceeds very slowly, the cornea becoming prominent and discoloured, and the patient suffering severe pain,—it may be necessary to puncture the cornea, which, although it will not perhaps admit the transit of the clot, will, by permitting the escape of the more fluid aqueous humour, relieve pain, and lessen the risk of that extensive degree of staphyloma which will almost certainly follow the pressure of the irritating body against the diseased and probably semi-gangrenous cornea. By adopting this practice, I have, on several occasions, succeeded in restoring a certain degree of vision, and have also prevented the occurrence of any disfiguring alteration in the form of the eye-ball.

A turbid state of the aqueous humour is commonly noticed in very advanced life, and, in a still greater degree, in connexion with inflammation of its secreting membrane, or of the iris, or anterior hemisphere of the crystalline capsule. In old age, the aqueous humour sometimes becomes whitish, and a milky fluid has been said to be effused into the chambers of the eye when the mammary secretion has been suddenly suppressed (*Rosas*[1], *Clemens*[2]).

The rapid healing of ulcers of the legs has been succeeded, according to the opinion of Clemens[3], by an effusion of puriform matter into the chambers of the eye, which, however, have assumed their customary clearness on making an artificial ulcer in the site of the original disease. This has occurred under my own observation only in connexion with some form of inflammation of the eye, arising from the rapid healing of a sore, with the influence of which the constitution had been long familiar. Two cases are recorded, in which an hydatid formed in the chambers of the eye[4]. I have related an instance in which a small and somewhat globular body was found in the chambers of the eye, which appeared to me to be a dislocated lens preserving its transparency[5]; but several surgeons who saw the case, considered that I was mistaken, and that, in fact, it pretty closely resembled that condition of hydatid disease described by Soemmering, Logan, and Mackenzie. It has been long known that a species of thread-worm has been found in the chambers of the eye in horses and various other animals[1], but I am not aware that it has been noticed in the same situation in the human subject. Woolhouse, Richter, and subsequently Beer, have stated that globules of quicksilver have been found in the anterior chamber of the eye in persons who have been using mercury pretty freely, for the cure of syphilis; and the two former authors mention that they have noticed bubbles of air in the same part of the eye independently of any external wound.

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[1] I am now attending a young lady suffering from periodical amaurosis (dependent on derangement of the uterine system), in the anterior chamber of whose left eye a considerable number of minute whitish particles are occasionally to be seen. They are visible only when the dimness of vision is very great, and are not associated with any uneasiness or manifest signs of inflammation.

[1] Handbuch, vol. ii. p. 671.

[2] Scriptores Ophthalmologici Minores, vol. i. p. 142.

[3] Opus citatum.

[4] An account of the first case, originally related by Soemmering, may be found in Lawrence's Treatise, p. 669, and in Schmalz's *Tabulæ Anatomiam Entozoorum Illustrantes.* For a description of the second, the reader may consult the twelfth volume of the London Medical Gazette, and also a pamphlet published by Mr. Logan, under the title of "Animalcules in the Eye."

[5] A Treatise on the Diseases of the Eye, &c., vol. ii. p. 49.

In the case of hydatids or worms existing within the chambers of the eye, it has been suggested to destroy the life of the parasitical beings, by passing an electrical current through the organ of vision; by the infriction of turpentine around the orbit; and by the administration of irritating and bitter medicines. It appears to me that the following rules ought to regulate our practice:—So long as the eye is free from material inflammation, no surgical means, at least, are necessary; but as soon as even a slight degree of irritation supervenes, an attempt should be made to remove it, by the application of cooling lotions, the administration of purgatives, and the adoption of counter-irritation in some convenient locality. If these means are insufficient—if the irritation rather increase than diminish—then it would be proper to evacuate the aqueous humour, by a very small incision of the cornea, made nearly at its margin. This simple proceeding may cause the death of the offending agent; but if it should not do so—if, on the secretion of a fresh quantity of aqueous humour, the worm or the hydatid should be found to be alive, and capable of creating great irritation, then it would be quite necessary to make an opening in the cornea, sufficiently ample to admit of its extraction.

AQUO-MEMBRANITIS. Kerato-iritis—*Rosas*. Inflammation of the capsule of the aqueous humour—*Wardrop*. Inflammation of the anterior chamber—*Lawrence*. Aquo-capsulitis—*Mackenzie*. Inflammation of the membrane of the aqueous humour was first clearly pointed out by Wardrop (Morbid Anatomy of the Human Eye) in the year 1808, seven years after the inflammation of the texture it envelopes (the iris) had been described with such admirable precision and distinctness by Professor Schmidt.

General observations.—The disease may be acute or chronic, and it may affect the whole or merely a part of the membrane. I have seldom observed the disease after adult age; under my own observation it has chiefly occurred in children of a strumous habit, with light hair, blue eyes, a thin skin, and a very delicate organization. Mr. Wardrop appears to have witnessed the disease very frequently, but many of the cases he has related are represented to have occurred in adult and elderly persons[1]. Mr. Lawrence says, "I used to see it in children from two to ten years of age: it is not common in older subjects[2]." Mr. Mackenzie speaks of it as a "rare ophthalmia[3]." Of nearly 4000 persons suffering from diseases of the eye, who fall under my notice annually, about twenty-five are affected with the form of disease under consideration; and of this number, one only, on an average, is more than twenty years old. When the membrane of the aqueous humour is inflamed, the inflammatory action is not disposed to spread to contiguous parts to the extent we might suppose, from a knowledge of its great proximity to other delicate textures. But, if it continues for a long period in a severe form, the lamellar texture of the cornea, the proper substance of the iris, and the anterior hemisphere of the capsule, are generally inflamed, but not, I repeat, to any serious extent, unless indeed the treatment should have been very inappropriate or altogether neglected.

Symptoms.—1. There is generally a faint zonular arrangement of pink vessels around the cornea, not actually in contact with it except at a few points, and then only at the fully established stage of the disease[4]. The zone is by no means clearly defined; it is as a faintly tinted and not very distinct circle of minute pink-coloured vessels, the general surface of the eye not appearing vascular, except on a close and attentive inspection; then, indeed, both the conjunctiva and the sclerotica are found to be streaked with a few enlarged vessels, and communicate to the organ, when cursorily viewed at a short distance, a peculiarly dirty and unhealthy appearance. As the inflammation subsides, the zone appears patchy and imperfect, and becomes of a darker colour, inclining to purple, and sometimes leaves the sclerotica around the cornea a little discoloured, as though it had acquired an extremely faint olive-green tint. If, instead of declining, the inflammation should increase and extend to other parts, the red zone will be more bright, vivid, and distinct, (I allude to what may be termed a pure and clear colour as distinguished from a cloudy and muddy one,) and, should the lamellar texture of the cornea be materially involved, the white line situated between the margin of the cornea, and the zonular redness, will cease to exist.

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[1] *Ploucquet*—Litteratura Medica Digesta sive Repertorium Medicinæ Practicæ, &c. tom. iii. p. 217. *Breton and Twining*—Transactions of the Medical and Physical Society of Calcutta, vol. i. *Lawrence*—A Treatise on the Diseases of the Eye, p. 666.

[1] Medico-Chirurgical Transactions, vol. iv. p. 163.

[2] A Treatise on the Diseases of the Eye, p. 274. London, 1833.

[3] A Practical Treatise on the Diseases of the Eye, p. 472. London, 1830.

[4] In all cases where the corneal portion of the membrane of the aqueous humour is specially inflamed, I have observed that the arrangement of vessels exists quite at the margin of the cornea, and that no approach to a distinct white line intervenes between the pink zone and the corneo-sclerotic junction.

2. At a very early period of the disease the aqueous humour becomes cloudy—slightly turbid, as it is seen to be in many acute forms of ophthalmia; and, on a careful examination, it will probably be found that the lining membrane of the cornea is also cloudy, that the polish of the iris is impaired, and that the pupil has a dull and smoky appearance. The deep-seated cloudiness of the cornea cannot, however, be confounded with the "bluish-white," the "ground glass," the "dew-drop," the "*glace dépolie*," appearance of the cornea, which is noticed when the superficial portion of its lamellar texture is the seat of inflammation. In the progress of the disease a few minute milky spots are observed at various parts of the inflamed membrane, sometimes upon its corneal (and when in this situation they are very distinctly seen), sometimes upon its iridal, and sometimes upon its capsular portions; and these somewhat dense spots will occasionally be surrounded by a filmy streaky matter, possessing a degree of opacity, intervening between that of the mere general muddiness and the limited densely opaque spots to which I have just referred. It has been stated by Mr. Wardrop, that these dense spots are the result of an intense degree of inflammation of the lamellar texture of the cornea; but as they occur near and around parts of the inflamed membrane, remote from the cornea, I am rather inclined to consider them as the effects or products of the inflammation of the serous membrane merely, such as occur in inflammation of the same tissue in other situations. I am satisfied, however, that they are more manifest when existing in the corneal portion of the inflamed membrane, and that when unusually dense and extensive, it is extremely probable that such great amount of opacity is partly owing to the inflammation of a neighbouring portion of the corneal lamellæ. When the inflammation has existed for several days the cornea appears prominent, and there is a sense of tension and undue fulness of the eyeball. If we continue to trace the progress of the inflammation, we find that the pupil becomes irregular, somewhat contracted, and very cloudy, the surface of the iris rough, unequal and deprived of its polish, and that various changes take place, which will be hereafter mentioned as the effects of the malady.

3. There is seldom much intolerance of light present, but there is generally an increased secretion of tears, but not to the same extent as may be noticed in inflammation of the lamellar texture of the cornea or iris.

4. The condition of vision is, from the first, impaired, and this defect increases as the disease advances, until, aided by the diminution in the size of the pupil, but chiefly by various inflammatory depositions, it may be wholly destroyed. The tension of the globe, the nebulosity of the cornea, the turbidity of the aqueous humour, and the cloudiness of the capsular portion of its membrane, sufficiently explain the impairment of sight, even at an early stage of the malady.

5. The first sensation of any approach to severe pain arises from the plenitude of the anterior chamber, as manifested by the prominent state of the cornea, and the patient's account of his own sensations; but the disease is rarely attended by any great degree of intolerance of light, and may continue for a considerable period without occasioning much suffering. Pain over the eye-brow, and sometimes hemicrania, are complained of, but it is only occasionally that they acquire any distressing degree of severity.

Constitutional symptoms.—The general health of those who suffer from this disease, when it is idiopathic, has, in general, become impaired for some time before it occurs; so that it would almost appear that derangement of the health was, in a certain degree, necessary to its existence; derangement of the health is undoubtedly favourable to its occurrence. The symptoms of feverish excitement, and constitutional derangement, which may attend, or proceed from, the inflamed condition of the eye are very variable, depending, for the most part, on the severity of the ophthalmic inflammation, its degree of protraction, and the nature of the remedies employed for its removal.

Sequelæ.—The distention to which the cornea is subject in consequence of the increased exhalation from the inflamed membrane, has, under my own observation, occasioned near-sightedness, and conical cornea; but I am not aware that it has had any injurious effect, beyond this, except such as relates to the cloudiness of its lining membrane, and, perhaps, also of its innermost layer. The aqueous humour is, at first, merely turbid, but it soon becomes more materially changed. I have seen small filmy matters, and also distinct flakes and globules of lymph floating about in it[1], and, on a few rare occasions, a thin purulent matter has been secreted. Sometimes the whole of the corneal portion becomes thickened, and coated with a layer of lymph, or the chambers of the eye may be nearly filled with a deposition of lymph. Sometimes the iritic or capsular portions of the membrane alone are thickened, and rendered opaque, either wholly or partially. When the iridal portion of the membrane of the aqueous humour becomes opaque and thickened, the iritic texture has generally been involved in the inflammation, and its colour has undergone some degree of alteration. The pupil may be diminished, and rendered irregular, by the formation of frenular adhesions, passing from side to side, or by the formation of a filmy opaque membrane within its centre. The opacity and thickening, with deposition upon the capsular portion of the membrane of the aqueous humour, has been sometimes mistaken for the effect of inflammation of the anterior hemisphere of the crystalline capsule. I am convinced that this error is committed by some modern writers of celebrity. It will be borne in mind, that the secreting polished surface of the membrane of the aqueous humour is directed *from* the capsule of the lens, to which its less polished, vascular, and comparatively flocculent surface, is connected; having in this respect a precise analogy to the mode in which the free, polished, secreting, and the attached, flocculent, non-secreting surfaces of other serous membranes are related. A trivial degree of inflammation of the capsule of the lens, just sufficient to render its texture slightly opaque, generally occasions an increased secretion within its cavity, which is known by its bulging towards the pupil, and rendering the iris, but not the cornea, convex. I have many times removed a lens surrounded by a thickened capsule, and a quantity of turbid fluid; but then the opacity or layer of lymph-like matter is deposited on what was previously the polished, secreting, lenticular surface of the capsule, whilst in the case of acute inflammation of the capsular portion of the membrane of the aqueous humour, the lymph-like matter, when at all considerable, is situated on the *corneal*, not the *capsular*, surface of that membrane. Here, then, is a ground of diagnosis founded on the products of the disease, when acute, which I am satisfied is not sufficiently understood[1]. Other changes in the membrane of the aqueous humour, besides those I have enumerated, are stated to succeed either a prolonged attack, or repeated attacks of inflammation; of these I have only witnessed its conversion into a tough cartilaginous layer, or a distinct osseous lamina. These morbid alterations are, however, exceedingly infrequent.

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[1] The fixed globules of lymph noticed in inflammation of the true iritic texture are not observed when the capsule of the aqueous humour is inflamed. In the former case the secreted matters are confined and retained by the enveloping membrane; but in the latter instance they are, if liquid, at once secreted into the chambers of the eye.

Causes.—The causes of aquo-capsulitis are, for the most part, the same as those which give rise to various other forms of inflammation of the eye, and they will be referred to in detail, in the article Ophthalmia. I have witnessed the disease after contusions of the eye, after wounds of the cornea, and more frequently as a consequence of the operation of keratonyxis; and on several occasions, in children, from bathing in canals or shallow streams of water, remaining as they sometimes do, with the legs immersed in that fluid for half an hour together during the middle of a hot day.

Diagnosis.—See inflammation of the cornea, of the iris, and capsule of the lens.

Treatment.—In commencing the treatment, it is important to bear in mind, not merely the severity of the local symptoms, but the state of health and constitutional vigour of the patient. I have subdued the severest forms of inflammation of the membrane of the aqueous humour by means of quinine, with very slight alterative doses of mercury,—mercury *not* given to the extent of producing salivation—when the disease has occurred in feeble strumous children; and this plan of management I adopted and recommended at a time when, as far as I was able to learn, it was the customary practice to treat the disease by means of mercury, as for the cure of common iritis[1].

If the patient, though young, be tolerably strong, and if the inflammation be decidedly acute, it would be desirable to apply a few leeches immediately above the eye-brow, to recommend small doses of mercury in some of its forms, and, with any suitable combination, to be taken until the mouth is slightly affected. A small blister should be applied behind one or both ears, just as one or both eyes may happen to be affected; and it seldom happens that both eyes are diseased in anything like an equal degree at the same time. As a local application, I generally recommend either a poppy fomentation, an aqueous solution of opium (prepared by adding half-a-pint of boiling water to four scruples of powdered opium, allowing it to stand for twenty minutes, then filtering for use), or a weak goulard lotion. I further advise that a mustard pediluvium be used every evening for about ten minutes; that the patient's apartment be darkened; and that the diet be of a mild unstimulating character.

The necessity for bleeding, and for its repetition, will be determined by the constitution of the patient, the severity of the symptoms, and the influence it may, if previously tried, appear to exert upon the disease. To bleed a weak scrofulous child for the cure of a disease which is often obstinate in duration, and chronic in its nature, and which, also, is often protracted from the debility of the subject in whom it occurs, is, in fact, still further to prolong its existence. When extensive muddiness of the pupil is present, with merely a slight degree of inflammation, and more especially if the neural surface of the cornea is cloudy and opaque by patches, the best plan of management consists in the administration of four or five grains of the hydrargyrus c. cretâ every evening, with three or four grains of quinine, taken in divided doses during the day; and to these means may be advantageously added the formation of a small issue in the arm. Even in some apparently hopeless cases, where the chambers of the eye have been nearly filled with lymph, I have occasionally had an opportunity of witnessing the restoration of a very useful degree of vision, by continuing this plan of treatment, until the gums have become slightly tender; and then persevering in the use of quinine, and the occasional administration of mercury in smaller doses, until every portion of the lymph has been absorbed, except that which has become securely organized. On this system I have just treated, with great advantage, a poor woman suffering from this variety of inflammation. The inflammation was not remarkably acute, but the neural surface of the cornea was spotted here and there with portions of lymph. The persevering administration of mercury in a mild form, together with the sulphate of quina, restored to her a tolerably perfect state of vision, although her disease had resisted for several months the various plans of treatment which had been tried before I saw her.

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[1] I have lately attended a girl (Mary Bird, æt. 13, residing in Great Hampton Street), in whom the distinction referred to in the text may be very clearly witnessed. There is a nearly circular opacity within the pupil, which is somewhat smaller in size than that aperture; the opacity is by no means dense, but it is fixed; a few delicate filaments (which are scarcely visible to the naked eye) are detached from its lower border to the back part of the pupillary margin; and the opacity itself may be seen, as it appears to me, to be placed not upon the lenticular surface of the crystalline capsule, but upon the corneal aspect of the capsular portion of the membrane of the aqueous humour. The distinction between the two diseases (inflammation of the membrane of the aqueous humour, and inflammation of the crystalline capsule) may, therefore, in respect to this morbid phenomenon, be beautifully observed.

[1] Midland Reporter, vol. ii.; Medical Gazette, vol. viii.

In the cases of children who have been under my care, where the inflammation has been somewhat severe and protracted, and where the sulphate of quina has not been serviceable, I have prescribed, with great advantage, an evening powder, containing five grains of mercury with chalk, and three of rhubarb, and also from five to fifteen drops of liquor potassæ, to be taken twice a day. Such children have generally had a furred tongue, fœtid breath, and tumid abdomen, so that, before commencing the treatment, I have thought it desirable to evacuate the bowels pretty freely with castor oil. I have tried the internal administration of iodine, but it has not answered my expectations, although it has sometimes been useful as a collyrium. A small teaspoonful of the following drops, administered in water two or three times a day, may prove serviceable in cases where the habit is sluggish, the pulse slow and languid, and where the upper lip, tips of the ears, and alæ of the nose, are in a state of hypertrophy :—

℞. Tinct. Iodinii, ʒiss.
Vini Ferri, ʒxivss. Misce.

In adults and elderly persons, where the symptoms of the disease have not entirely disappeared after venesection and the use of mercury, and where quinine and various mineral and vegetable tonics have been prescribed in vain, I have derived advantage from the administration of the carbonate of iron, or small doses of turpentine, and in other instances colchicum has produced a very satisfactory effect, even when it has appeared almost necessary to relinquish in despair all further attempts to relieve. The indications for the one or other of these remedial agents are afforded by the characters and peculiarities of the constitution.

During the acute stage of the disease, when the aqueous humour is especially cloudy, the cornea tense, and apparently unduly prominent, the tunics of the eye-ball distended, and the frontal pain severe, it has been suggested to puncture the cornea and discharge a part of the aqueous fluid[1]. The immediate effects of this operation are certainly very agreeable, but, unfortunately, they are also very temporary, whilst the direct injury inflicted, and the pain produced by this surgical process, are very considerable. I do not now express any theoretical objection, but, on the contrary, advance an opinion which has been formed after having repeatedly adopted the practice I am reluctantly compelled to condemn. In the cases in which I have evacuated the aqueous fluid on account of inflammation of its secreting membrane, all the symptoms relieved by the operation have returned with equal and oftentimes increased severity, in twenty or thirty hours afterwards. The pain occasioned by the operation is very severe, for, in order to perform it properly, the eye-ball must be steadily fixed, and exposed to a pretty strong light. To do this simple operation on a healthy eye furnishes no correct guide to the trouble experienced when performing it upon an organ in a condition of acute inflammation. As, however, the practice is occasionally adopted, I shall give an account of the mode of performing the *operation*.

The patient should be placed upon a table, as for the operation of extraction, and it is found advisable to bind up the eye upon which it is not intended to operate, as a means of steadying its fellow. A cataract needle (sharp at the point, flattened and sharp at the sides, having a delicate groove running on that side of it opposed to the operator, when introduced with its flat side directed towards the iris, but not continued quite to its point,) is then to be passed through the cornea into the anterior chamber for a short distance, when the aqueous humour will spirt through the opening it has made. It is desirable that the instrument be so made that that part of it a little behind its point shall be so small as not quite to fill up the corneal opening, and that the point of the instrument shall not project far into the anterior chamber, lest the iris should be entangled and injured. The puncturing of the cornea does not much injure its texture, nor produce severe pain, but the unavoidable exposure of the eye to light, and the degree of compression of the eye required for the purpose of securely fixing it, occasion, in an acutely inflamed state of that organ, the most intense anguish.

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[1] This practice was first suggested by Dr. Whyte, (Med. and Physical Journal for March, 1802) for the relief of acute inflammation of the eye; it was, however, originally recommended by Mr. Wardrop, as a means of relieving the form of disease under consideration, in addition to its applicability to other varieties of ophthalmic disease. See his opinions upon the subject in the third volume of the Edinburgh Med. and Surgical Journal, and in the third and tenth volumes of the Medico-Chirurgical Transactions.

Hitherto I have confined my remarks to the more acute forms of inflammation of the membrane of the aqueous humour, but there is a chronic and also a strumous variety of the disease, to which it will be necessary to refer.

I have had occasion to witness a state of eye which has continued for a considerable time, and in which there have been no acute symptoms whatever. There has been a faint blush around various parts of the cornea,—in some places extending quite to its margin, in others, terminating a little anterior to its border; a few large trunks within the sclerotica have proceeded from the periphery of the globe at its directly upper, lower, and lateral parts, forming an interrupted and faintly marked and festooned vascular zone in that situation. There has also been a nebulous state of some part of the membrane of the aqueous humour, but no definite lymph-like patches, no pain in the eye or forehead, and no intolerance of light. Sometimes the anterior part of the eye assumes an appearance of undue plenitude, but this is by no means of frequent occurrence. This state of things (which I conceive to be chronic inflammation of the membrane of the aqueous humour) will sometimes continue for a long period. Its mode of treatment is very simple,—no active measures are required; counter-irritation may be continued in some convenient situation (the back of the ears or the temple are generally to be preferred) until the disease has nearly disappeared: hydrargyrus cum cretâ, with rhubarb, or some other medicine adapted to the improvement of the general health, may be administered[1]; and it will be most desirable not to employ the eyes in any way requiring minute vision, nor to expose them, unprotected, to the influence of a brilliant light.

Strumous inflammation of the membrane of the aqueous humour differs but little in its local characters from those of common inflammation of this membrane. The disease is, however, less acute in its symptoms, and generally of longer duration. Like other forms of scrofulous inflammation of the eye, it is often attended with great photophobia and profuse lachrymation. Under my own observation it has been successfully treated by the administration of the sulphate of quinine, and small doses of hydrargyrus c. cretâ, given until the mouth begins to be slightly affected. Counter-irritation, either in the shape of an issue in the arm, or an occasional blister behind the ears, is serviceable, or a slight degree of irritation may be maintained in the latter situation, by the infriction of the tartarized antimony ointment. The local applications I have found most serviceable have been a weak solution of hydriodate of potass (six grains to the half-pint of distilled water), or the goulard lotion (prepared by adding half a drachm of the liquor plumbi acetatis to half an ounce of the wine of opium, and half-a-pint of distilled water).

In conclusion, I would remark that, like all diseases which are very generally associated with derangement of the health or defect of the constitution, inflammation of the membrane of the aqueous humour is characterized by a great proneness to relapse, when it has once occurred, unless appropriate treatment be continued for some time after the appearances of inflammation have been dispersed, and unless great care be taken to prevent any undue use of the eye, more especially by artificial light.

(*Richard Middlemore.*)

ARCULUS, Lat.; *arceau*, Fr.; *Schutzplatte*, Ger. A semicircular hoop of wicker, wood, or strong iron wire, employed to protect diseased parts from the contact of the bed-coverings, or the shock of anything that may approach them. These cradles are in common use in hospital practice in cases of fractures, burns, erysipelas, &c. Their use was once prescribed by law in the states of the Grand Duke of Tuscany; it being forbidden to nurses to sleep with their infants unless they protected them in this way from being overlaid during sleep.

ARGENTI NITRAS, the nitrate of silver. The crystallised salt is almost exclusively confined to internal administration. In the fused form, lunar caustic, (*nitrate d'Argent fondu, pierre infernale*, Fr.; *Geschmolzenes salpetersaures Silver, der Höllenstein*, Ger.;) it ranks as one of the most generally useful applications employed in surgery. Both as an escharotic and a stimulant its effects can be nicely graduated; the pain arising from it is in general slight, and of short duration; yet it acts promptly and decisively, at the same time that its chemical operation upon a part renders absorption impossible. The nitrate of silver is not, however, to be regarded merely in the above-mentioned characters, since it exercises a marked influence, as Mr. Higginbottom has shown, in the resolution of superficial inflammation, exemplified in the effects produced by it on congested vessels of the conjunctiva and other mucous membranes, and in the power it sometimes exhibits of arresting erratic erysipelas and inflammation of the absorbents. This seems rather to depend on its astringent or tonic properties, or on some peculiar power exercised by it on the capillaries; perhaps, in some measure, on the serous effusion and vesication it excites.

It is employed externally in the solid form or in a state of solution.

For convenience of manipulation, the solid stick or cylinder of nitrate of silver is securely fixed in a silver tube or case with a handle attached to it. If the surface to which it is about to be applied is dry, it must be moistened; the nitrate is then passed over it with more or less rapidity and frequency according to the sensibility of the part, or the effect we are desirous of producing, leaving the surface exposed, wherever that is possible, until it is dry. The eschar, or pellicle, resulting is superficial on the skin, and still more so on the mucous membranes: in the former case it gradually changes from a light silvery hue to black; and unless much vesication has been excited, separates from the cutis, and peels off about the fifth or sixth day.

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[1] To avoid repetition, I purposely abstain from an elaborate consideration of various means of improving the general health (such as clothing, exercise, air, &c.) in the present article.

The solution is best applied by means of a camel's hair brush or a fine pencil of lint; for conveying it to the back of the fauces, pharynx, &c., the sponge attached to the probang is well adapted.

The solid lunar caustic is most commonly resorted to for the purposes of repressing exuberant granulations, suspending the progress of certain gangrenous affections, destroying warts, corns, condylomata, &c., and removing the callous edges of indolent ulcers, to the surface of which it is also applied with the view of inducing cicatrization. (See art. ULCERS.)

A coating formed by it over excoriations of the skin of the sacrum, in bedridden patients, affords an excellent defence to the abraded surface, which will frequently cicatrize beneath it.

A similar treatment of superficial burns and scalds has long been successfully followed by Dr. Fricke at the General Hospital of Hamburg.

It is employed with advantage in chronic inflammation of the conjunctiva, in ulceration of the margin of the eyelids, and in ulcerations of the cornea, with or without protrusion of the iris; the precaution of immediately letting fall a drop of sweet oil upon the spot will prevent its diffusion over the rest of the organ.

It is serviceable in checking the ravages of lupus and cancerous ulcerations of the face; and will be found useful in all inveterate ulcerations, as those, for instance, which occur about the nails. Mr. Higginbottom strongly recommends it in the early stage of whitlow, and even after suppuration has taken place, first evacuating the matter. Also in Housemaid's Knee (inflammation of the bursa mucosa of the patella). In all cases of abscess, however, the coating produced by nitrate of silver is likely to be injurious, by impeding the progress of the pus towards the surface, and causing it to burrow in search of a distant outlet.

The propriety of its application to chancres is disputed by some practitioners, although strongly insisted upon by others. (See SYPHILIS.) Dr. Fricke, of Hamburg, is an advocate for its employment in the form of an ointment, which is left in contact with the sore for two or three days. His formula is as follows:—℞ Argent. Nitr. Cryst. pulv. ℈ss. Ung. Zinci ʒij. Bals. Peruv. ʒss. ɱ diligenter.

In croup, and especially in chronic inflammation of the mucous membranes of the fauces, pharynx, and nasal fossæ accompanied by adherent sloughs or false membranes, its use is attended with very beneficial results; the adventitious surface becomes dry, separates, and leaves the membrane beneath healthy. Of its successful application, with similar views, in thickening of the membrane lining the meatus auditorius externus, Mr. Earle has reported instances in the Medico-Chirurg. Trans. vol. x.

Aphthous ulcerations of the mouth, also, heal readily under its influence.

In the treatment of stricture of the urethra, the success obtained by Hunter, Home, and Whately, in this country, and by Ducamp, Lallemand, and others, on the Continent, have established its claim to merits of a high order. (See STRICTURE.)

M. Desportes has been led by analogy to apply it to the cure of obstructions of the nasal duct.

By destroying their edges, or internal lining, and surrounding their orifices with an eschar, the nitrate of silver will often bring about the contraction and cicatrization of fistulous openings. We may rely upon it, in the majority of cases, for suppressing prolonged hæmorrhage from leech-bites, or from the gums after extraction of teeth; and, in solution, it is frequently efficacious in putting a stop to chronic hæmorrhages.

Solutions of various strength are used as injections in gonorrhœa and leucorrhœa; also, in puriform discharges from the meatus auditorius, ascertaining first, that the membrana tympani be sound; as an application to the excoriated nipples of nursing mothers, in which it affords immediate and permanent relief; and as collyria in superficial inflammations of the eye. (See articles on those subjects.)

(*Henry T. Chapman.*)

ARM, BEND OF. Under this title will be described the elbow-joint and all the important surrounding parts which are within the arbitrary limits of about two inches above, and two inches below, the centre of that articulation. Many objections may be made to the words which head this article; nevertheless they appear to us less objectionable than most others. In fact there is great difficulty in finding appropriate denominations for this branch of surgical science, owing partly to the want of precision in many of our English anatomical expressions. Some might prefer calling this portion of the upper limb "the region of the elbow:" this name, however, has been very differently and very improperly used; its strict anatomical meaning is the back part of the arm-joint, formed principally by the posterior and superior extremity of the ulna. Thus William Cowper[1] speaks of

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[1] Myotomia Reformata, p. 177. London, 1724.

"the olecranon, or elbow." Most authors follow this example, and employ the phrases, "bend of the elbow-joint[1]," "bend of the elbow[2]," "front of the elbow[3]," &c., to denote the fore-part of the arm-joint. Some authors apply the word "elbow" incorrectly, as thus: "all recent dislocations of the elbow[4]," which agrees exactly with Dr. S. Johnson's[5] singular definition of "*elbow*,"—"the next joint or curvature of the arm below the shoulder." The best continental writers seem also to have experienced some difficulty in choosing terms for defining this region: hence they differ considerably. M. Gerdy[6], for instance, in his interesting and laborious work, has described the superficial parts of the bend of the arm in his chapter "On the articulation of the elbow." M. Velpeau[7], in the last edition of his surgical treatise, makes a "humero-cubital region," which he divides into two sections; the one is the bend of the arm, or the fore part of the limb; the other is the elbow, or the back part, which comprises the two tuberosities of the condyles of the os humeri, the olecranon, and the parts situated upon or around these points. M. Blandin[8], whose work, if not the best upon this matter, is certainly the most surgical and practical, describes this part under the head of "region of the elbow." M. A. Berard[9] has adopted the same plan, and M. Malgaigne[10], in his new volumes, approves of that arrangement, but calls its posterior surface the "olecranion region." M. H. M. Edwards[11] has improperly confounded this important region with the arm and fore-arm, in his "middle region of the arm." Mr. Lizars, in his little book, which is entirely anatomical, nearly follows the same order, making no separate region for the elbow, but describing it in his "anterior and posterior brachial regions[12]. B. G. Seiler, the distinguished anatomist of Dresden, has also spoken of this region when treating generally of the "anatomia extremitatum[13]." The thesis quoted in the note, like Lizar's little book, gives a sort of catalogue of the subjects, comprehending surgery as well as anatomy, which should enter into a course of lectures upon this matter. This modest and learned production, which I have never seen noticed by any writer, shows that its author was perfectly aware, even at that early period of his career, of the utility of surgical anatomy, and how it ought to be prosecuted to become useful to the surgeon. Indeed it is surprising that Seiler's "Outlines" did not stimulate his laborious countrymen to complete a work upon that plan. To this day, however, no such treatise of any importance has appeared in Germany. In England, France, and America surgical anatomy has been cultivated more extensively, as well as more successfully; a circumstance which may reasonably be explained by surgery being more advanced in those countries than elsewhere. Without endeavouring to prove the impropriety of many of the denominations which have been used by the able writers above mentioned, it is sufficient to know that they have all given a more or less comprehensive description of this region; and as we strongly recommend the perusal of these works for the valuable information they contain, we shall make a point of correcting any errors which may have escaped their authors.

The arm, on account of its being constantly in action in the various pursuits of pleasure or of toil, and also on account of its peculiar situation, detached from the body, and increasing its lateral dimensions, is continually exposed to injury. The bend of the arm, in particular, claims the student's care, as the region in which his anatomical skill is generally first tested in the operation of bleeding; it being considered a fair and easy trial for his young hand, although no operation is at times more trying, or more liable to be followed by serious consequences. The bend of the arm is also the seat of a number of diseases, often very complicated in their nature, and requiring great attention and manual dexterity from the surgeon; and on these grounds, therefore, the greatest care ought to be bestowed on the description of this region. The outward forms, so worthy of being thoroughly studied by the practical surgeon, and which nevertheless have been so greatly neglected, and so imperfectly understood, we shall also endeavour to explain.

As this region varies its form with every change of position, the type of our description will be the arm extended, and the hand in complete supination; this being also the position of the limb during the performance of most surgical operations in that part. There are four sides or surfaces to this region:—the anterior, or bicipital; the posterior, or olecranial; the external, or radial; the internal, or ulnar. The bend of the arm presents great variety in form, size, and proportions, at different periods of life. Thus the three stages of infancy, full growth, and old age have each its peculiarities, which, for the acute observer of the human form, are sufficient to distinguish them from each other. The divers pursuits of mankind likewise produce many changes which are not without interest. The difference of sex is another great cause of diversity in the form of this region; but as it would be impossible to do justice to these points without incurring the blame of treating the subject more for the artist than for the surgeon, we shall content ourselves with pointing out the most important practical bearings connected with them, taking our description from the male adult arm, in which nearly all the parts are upon a larger scale, and more palpable to the anatomist than in the other periods of life, or in the other sex.

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[1] The Elements of Anatomy, by Dr. Jones Quain, p. 330. London, 1836.

[2] Dublin Dissector, p. 117; a very good manual of Anatomy, by R. Harrison. 1836.

[3] Dr. Todd's Cyclopædia of Anatomy and Phys. Art. ARM, p. 217; by John Hart.

[4] Cooper's Dictionary of Practical Surgery, p. 403. London, 1830.

[5] English Dictionary, fol. ed.

[6] Anatomie des Formes Extérieures du Corps Humain, p. 180. Paris, 1829. "De l'articulation du coude."

[7] Traité Complet d'Anatomie Chirurgicale, tome ii. p. 411. Paris, 1837. 3rd Edition.

[8] Traité d'Anatomie Topographique, p. 515. Paris, 1834.

[9] Dictionnaire de Médecine, 2de Edition, tome ix. p. 204. Art. COUDE.

[10] Traité d'Anatomie Chirurgicale et de Chirurgie Expérimentale, tome ii. p. 441. Paris, 1838.

[11] Manuel d'Anatomie Chirurgicale, p. 272. Paris, 1827.

[12] Heads of Demonstrations on Regional Anatomy, p. 111. Edinburgh, 1836.

[13] Page 22 of his Commentatio Primas Lineas Prælectionum Anatomiæ Chirurgicæ complectens, &c. Vitebergæ, 1802.

The bend of the arm, especially in the male, has a somewhat irregular shape, presenting several prominences and depressions. The antero-posterior diameter is much less than the lateral or transverse, which reaches from the radial to the ulnar side. The fore-part, or front surface of this region is flattened or hollowed about its middle; the posterior and lateral sides, on the contrary, are convex. The middle anterior depression is of a triangular shape, more so when the integuments are removed, and contains the most important parts in this region. This depression is continued up the arm on each side of the biceps, and gives that flattened shape in the male arm which is scarcely perceptible in females, owing to their osseous and muscular systems being less developed, and to the greater abundance of adipose substance, which fills up all the depressions, and gives their limbs that beautiful rotundity which constitutes the peculiar charm and grace of the female form. The posterior side of this region forms the elbow; in its middle a bony projection, called the olecranon, may always be seen or felt. The external or radial side extends from the middle depression, is convex, and surrounds the radius; it projects much beyond the outer line of the arm, which makes the upper part of the fore-arm much wider than the arm itself. The inner or ulnar side also commences from the middle anterior hollow of this region, is likewise convex, and presents a bony prominence, called the tuberosity of the inner condyle of the os humeri, which is always visible, or easily felt by the fingers, and gives great character to the male arm. On each side of the olecranon are two distinct and well-marked depressions or furrows, which may be denominated the radial and ulnar depressions; but their description will be more fully given when the deeper parts are examined. There are also some other furrows, which merit notice, and will be explained hereafter. These outward forms have rarely been correctly delineated by the great masters of painting; however, some of the modern French school, and we must place David, Ingres, and De la Roche among the first, have given the most splendid specimens of correct anatomical drawing[1].

The skin at the anterior surface of the bend of the arm is very thin and smooth, contains merely fine small hairs, and presents a number of transverse folds or lines, caused, as at the knee, foot, wrist, &c., by the continual flexion, or bending of the part. In fat persons, in women, and in young children, there are one or two well-marked lines, which extend across this region. Owing to the delicate nature of the skin in this place, the veins are frequently perceptible, by their colour appearing through the integuments, and by their rising above the surface, and thus marking their course. The skin is thinnest at the middle of this region, becoming somewhat thicker as it proceeds from this spot: here, also, it is more vascular, and contains a greater number of superficial nerves, which are principally branches of the intercostal and musculo-cutaneous nerves, than at the other sides of this region. The delicacy of its texture may help to explain the frequency with which many diseases, such, for instance, as herpes, ezcema rubrum, and prurigo, manifest themselves in this part. That singular insect, the acarus scabei, seems to show a decided predilection for this situation. During the extended state of the arm, although the skin is not very loose, it may nevertheless be pinched up into folds. At the posterior surface, or elbow, it presents a number of small irregular folds, which are most marked in strong men, and in whom the olecranon is always very prominent. The cuticle is very rough to the touch, owing, apparently, to a scaly state of the epidermis. When the fore-arm is bent upon the arm, this rough surface becomes quite smooth and tense, and is generally tinted with a reddish hue. During the extended state of the limb, the fingers may grasp a large fold of the skin, but by pulling it, even forcibly, no tension of the integuments in front of this region can be produced: this is explained by the strong adhesion of the skin to the fibro-cellular sheath which surrounds the bursa mucosa, and attaches itself to the olecranon, and to the tuberosity of the condyle of the os humeri. This fact equally accounts for large tumours in this region not affecting the skin in front of the arm. Owing to these adhesions of the skin to the fixed points beneath, it is important in all surgical operations to remove as little of it as possible, as otherwise there would be great difficulty in bringing the lips of the wound together. On the outer or radial side the skin is thicker, and mostly covered with hairs; on the ulnar side the skin is soft and thin. By pinching up a fold, and pulling it forwards, it will be found to connect itself to the tuberosity of the inner condyle of the humerus.

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[1] Girodet's picture of the "Deluge" is a sort of view of the three great varieties in the human form. Here we see the aged father's sinewy arm clasping the neck of his athletic son, who bears him upon his back, while the son's right arm saves his fair companion from a watery grave: a young boy and a babe, supported by their mother's arms, complete this well-drawn group. Among the Grecian statues there are a great many astonishing representations of this difficult region; none, perhaps, are more perfect than those of the "Knife Grinder" and the "Boxers" of the Tribune, the "Dying Gladiator" of the Capitol, and the "Gladiateur Combattant" of the Louvre.

Immediately underneath the skin, and adherent to it, is a very important layer of adipose tissue, which presents many points worthy our notice. It is generally, though erroneously described as surrounding the bend of the arm. It abounds chiefly in the front of this region, and is most developed in young children and females. In this situation it forms a sort of cushion, which covers the veins, and frequently prevents their being seen; by its softness and yielding nature it must likewise prevent any sudden or undue pressure upon the nerves and blood vessels, and in the same way diminish the ill effects of violent muscular contractions. From the abundance of adipose tissue, especially in females, the surgeon often finds great difficulty in performing venesection. Sometimes a small quantity of fat protrudes through the puncture made by the lancet, which prevents the proper flow of blood, causes thrombus, and is often followed by slight suppuration of the wound. When this accident occurs, the surgeon should be particular in returning the protruded part, or to remove it by cutting it away with the blade of his lancet, and close up the wound carefully. The posterior surface of this region, or elbow, contains very little fat; and why this difference? Is it not because there are here no important parts to guard! We never see, even in nature's sports, any large vein or artery passing superficially in this course, and requiring protection. The ulnar nerve can hardly be considered an exception; it is not strictly superficial; it lies in a groove, which is well protected by two bony projections. An accumulation of adipose tissue, far from improving the structure of this part, might produce considerable impediment to the free motions of the elbow-joint, and be the source of numerous diseases.

Nevertheless the skin at the elbow evidently requires particular protection, to prevent its being frequently bruised by sudden and violent pressure against the hard and resisting surface of the olecranon. This is done by means of a bursa mucosa, which allows great mobility of the skin, and effectually prevents many injuries that otherwise must occur from blows, &c. The adipose tissue, which is found in abundance at the lower and back part of the arm, almost suddenly disappears opposite the upper end of the ulna; hence, also, in corpulent persons, instead of the olecranon forming a slight and natural projection when the limb is extended, a hollow is observed, the fat accumulating around that projection, and rising above its surface. In several other points of this region the fat is also scanty, particularly upon the external condyle of the humerus, and opposite the head of the radius. This might also appear an imperfection in the conformation of the limb. It must be remembered, however, that these bony surfaces are round and smooth, and allow the skin to roll over them with the greatest ease, without even the assistance of a synovial membrane. This almost total absence of fat opposite the articulation of the head of the radius is in a great measure the cause of that depression, called in popular language the "dimple of the arm," which in babes is only large enough to contain a pea. In females of fine mould it is much larger, and gives a peculiar charm to the arm it adorns. M. Gerdy (Op. cit. p. 187) has not rightly explained the cause of this depression. He attributes it almost entirely to the muscular radial eminence. Owing to the want of adipose tissue, the surgeon should avoid applying much pressure upon the integuments in these situations, lest their vitality should be destroyed. The radial dimple may be filled up by the head of the radius when dislocated backwards, and the skin may be exposed to ulceration by that bone pressing against it. The tuberosity of the inner condyle of the humerus is another point where no fat is observed; a soft cellulo-fibrous substance occupies its place, and assists the skin in sliding over it. This displacement of the skin is easily seen during flexion of the limb, by marking it with ink, and following its displacement with the eye.

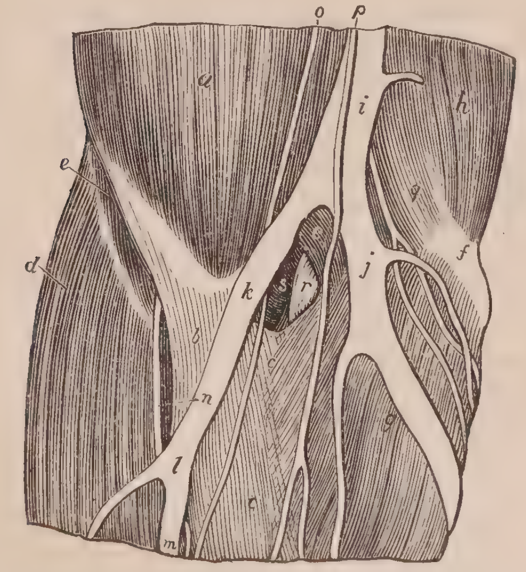
The adipose substance in front of this region is frequently the seat of various forms of inflammation, especially phlegmonous erysipelas following venesection. Sometimes suppuration affects the fat which surrounds the veins in the form of canals. The matter may be pressed out of the wound made by the lancet, and has often been supposed to proceed from the veins themselves.

Lipomatous tumours are sometimes met with in front of the region of the elbow: their removal requires great prudence. In fact the surgeon ought never to make an incision in this situation without first applying a bandage round the arm as if he were going to bleed the patient. He will thus be able to mark down with ink, if he thinks proper, the exact course of the larger veins; indeed this precaution should always be resorted to whenever an operation is performed upon parts where the most perfect knowledge of anatomy cannot, either from irregularity in the organs, or from various displacements by tumours or other diseases, avail in establishing their precise situations. I have several times witnessed the value of this practical truth. A patient with abscess of the neck came under M. Lisfranc's care at the hospital of "La Pitié." This gentleman gave a lecture upon the safest manner of opening such tumours, when surrounded by important organs. He did not tell his pupils to endeavour to note down the precise course of the large veins. He ordered his assistant to plunge the bistoury into this abscess, which was immediately followed by a gush of venous blood. The external jugular vein was injured : an accident which might perhaps have been avoided by the simple precaution indicated above.

A thin superficial cellular fascia lies immediately beneath the layer of adipose substance, covering the veins and subcutaneous nerves, and united to the common aponeurotic sheath by fine cellular tissue. This superficial fascia is not always very distinct ; it is seldom strong : nevertheless it merits notice, as will be shown when the veins are described.

The veins in front of this region are very irregular, and seldom represented alike in anatomical drawings. Their names even have often been changed. The principal varieties in these vessels may be classed in the following order :—1st, The veins in both arms are rarely alike. 2ndly, They may be more numerous than usual, and then the larger trunks will be found smaller than natural ; or they may be diminished[1] in number, but larger than ordinarily. 3rdly, They may be regular as to number, but changed in their positions. 4thly, Or they may be irregular in number, in position, and in size. The cutaneous and subcutaneous veins of the arm (as well as of every other part of the body) can be beautifully injected by the medium of the aorta, or brachial artery. I lately saw, at Leipsic, a splendid preparation made in this way, and under the direction of that distinguished anatomist, Prof. E. H. Weber.

Fig. 108.



This sketch represents several common varieties in the number and position of the veins and musculo-cutaneous nerves. The median basilic vein will be seen to follow nearly the course of the brachial artery. a, The biceps muscle of the right arm. b, The biceps tendon giving off the "fascia tendinosa," c c c, which has been opened to show the exact situation of the brachial artery s, and median nerve r. d, Supinator radii longus. e, Brachialis internus muscle, which sends off an aponeurotic expansion in this situation. f, The tuberosity of the inner condyle of the os humeri. g, The common aponeurotic sheath of the fore-arm which, in this point, covers the pronator. R, Teres muscle. h, The triceps muscle. i, The basilic, or "axillaria externa" vein. j, The cubital or ulnar vein. k, The median basilic vein, or mediana communis. l, The point where the "vena communicans" joins the radial vein m, and the median basilic, and cephalic vein, which, in this arm, was entirely wanting. n, The external musculo-cutaneous nerve, which is almost constantly regular in its situation. o, Outer branch of the internal musculo-cutaneous nerve. p, and q, Inner branches of the same nerve passing before and behind the veins. r, Median nerve. s, Brachial artery.

Great confusion in the names of these veins has been caused by modern writers changing the old nomenclature, and sometimes by applying the same name to very different veins. Dr. Jones Quain has given a confused description of these vessels in his manual of Anatomy (p. 579). He dislikes the terms "basilic and cephalic," "*which serve no useful purpose.*" It is somewhat singular that this anatomist should have chosen an irregular distribution of these veins in his collection of drawings[1], which a student might in vain endeavour to understand by referring to the above-named manual.

As the student may frequently be perplexed when he refers to different writers for a complete knowledge of these veins, we shall briefly explain these difficulties. The nomenclature of these vessels was formerly very simple. Thus that able anatomist, Camper, has given an excellent description of the superficial veins and nerves of the arm, and has enriched his work with two beautiful line-engravings, which represent these parts in their most ordinary form. Camper employed the most common names in use : thus ; he calls the cephalic vein the "vena humeraria, vel cephalica," which he describes as arising from the fore-part of the wrist, then running along the front of the fore arm, and uniting at the bend of the elbow to the "mediana simplex," now called the median basilic. Here it also receives one or more external or radial branches, and then proceeds up the arm to the clavicle. Therefore this humeral or cephalic vein corresponds to the "median vein," to the "common median vein," to the "anterior radial vein," to the median cephalic and cephalic veins of recent writers[2]. The radial veins are considered merely as branches of the cephalic vein.

The "basilic, or axillaria externa," is formed by the anterior and posterior cubital veins, which, at the bend of the arm, unite together and form a short and large trunk called the basilic, which is also joined to the cephalic by a large vein, which from its position was formerly named the median vein of the arm; it is now known by the name of "median basilic." The largest and most regular, and most superficial vein, is the median basilic; M. Cruveilhier[1] nevertheless assures us, that the median cephalic is larger. M. Gerdy[2] has compared the most regular distribution of these veins to the form of the letter M, the two upper extremities of which would give off the cephalic and basilic veins, the three lower extremities would receive the radial, the common median, and cubital veins; the two middle strokes of this letter represent the median cephalic and median basilic; this comparison may facilitate the recollection of the most regular distribution of these veins, although, according to M. Lebaudy[3], this "regular disposition" of the veins of the arm will be sought for in vain. In describing these veins, authors have not paid sufficient attention to one called the "communicating vein," which we consider a very important vessel, and seldom wanting. M. Velpeau[4], in speaking of this vessel, says, "the median vein divides into three branches, the first is very short, and called by M. A. Berard[5] the perforating vein: it empties itself directly into the deep seated veins, in the same way that the saphena vein does into the crural vein." This comparison is not quite just; the saphena vein throws its blood into the crural vein, whence it cannot return, owing to the existence of valves which prevent this retrograde motion; in their diseased state, these valves may become "*insufficient*," and hence those fatal hemorrhages from bursting of the saphena varicose vein. Instead of considering this vein a superficial vessel, it is more correct to view it as a deep-seated vessel, which unites these two order of veins; the blood also flows from the deep into the superficial veins of the arm; and here again the analogy with the saphena vein fails. We prefer calling this vessel the "vena communicans," a name used by all the best writers and more correct than the one lately proposed by M. A. Berard. In our dissections we have always found this vein existing, and always in the same situation, at the outer side of the tendon of the biceps muscle, in that ridge formed between the pronator R. teres[6] and supinator R. longus muscles, where an opening in the aponeurotic fascia allows it passage, and which is probably somewhat enlarged during the contraction of the biceps muscle, as M. Berard justly remarks, owing to the peculiar arrangement of the "fascia tendinosa bicipitis." I have seen this vein when the median vein was absent; in other cases when the cephalic was wanting. I have never observed it on the inner side of the arm, although I have made repeated dissections of this vein; in fact it appears much more regular than the other veins of this region. When closely examined, this communicating vein will appear to be formed by the trunk of the deep-seated radical vein, which passing through the aponeurotic opening, throws itself principally into the median basilic vein. This seems to be the case in M. Lebaudy's plate, in which it is well delineated; sometimes, on the contrary, it empties itself mostly into the median cephalic vein: it often contributes greatly in increasing the size of both these veins, as may also be observed in Dr. Quain's plate. The great purpose of this vein is to form a communication between the superficial and deep veins on the outside of the biceps tendon, an empty space existing between the muscles, which allows the blood to pass uninterruptedly from the large and deep to the superficial veins, by means of this communicating vessel: this vein is also provided with valves which prevent the blood returning from the superficial to the deep veins, which is another reason for not comparing the saphena with the communicating vein. The saphena might with more propriety be compared to the basilic vein, which perforates the aponeurosis of the arm, and discharges its contents into the deep vein. It is a common practice during the flow of blood from the vein of the arm, to order the patient to work his fingers, when at each motion the blood will generally jerk out with new vigour, and in a larger stream; in moving the fingers, the flexor muscles contract and propel the blood from the deep-seated veins into the communicating branch. Many persons account for the increase of the stream of blood by admitting numerous anastomosing branches between the superficial and deep veins of the fore arm; but where are these branches found? Besides, the superficial veins are supposed to send their blood into the deep veins; to say nothing of their being little influenced by muscular contraction, which evidently takes place beneath them; the blood sometimes does not jerk out by working the fingers; how is this explained? Simply because the lancet has opened some vein which does not receive blood from the communicating vein. When the veins of the arm are small, and the surgeon finds difficulty in feeling them, we strongly recommend him to order his patient to "work" his fingers forcibly; this will distend the veins with blood, and allow them to be better opened by the lancet.

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[1] See Fig. 1.

[1] See plate 36 of a Series of Anatomical Plates, &c. Fasciculus 42. London, 1837.

[2] Refer to "Heads of Regional Anatomy," by A. J. Lizars, p. 112; Bourgery's Traité d'Anatomie, plates 37, 61, 63. See also Meckel, Bichat, Boyer, Weber, Harrison, Blandin, Velpeau, Malgaigne, &c. &c.

The ancients supposed the cephalic vein went to the head, hence its name. The basilic vein of the right arm was anciently called the hepatic vein; while the basilic of the left arm was termed the splenic vein, from an erroneous notion of a great sympathy between them and the liver and spleen. Hence, also, the preference they gave in bleeding to the one or to the other vein, according to the organ diseased.

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[1] Anatomie Descript., tome iii. p. 299.

[2] Anatomie des Formes, &c. p. 183.

[3] Anatomie Médicale et Chirurg., p. 95, dans Journal des Con. Medico-Chirurg. Paris, 1833.

[4] Anatomie Chirurgicale, tome ii. p. 421.

[5] Diction. de Médecine, 2nd edit., tome ix. p. 217.

[6] Peter Camper has not delineated this vein in his beautiful engraving of the arm. M. Lebaudy, in his sixth plate, has given a correct representation of this vessel. My learned friend M. Velpeau has omitted this view in his fourteenth plate, which is badly executed, all the parts being pulled out of their natural position. Dr. Jones Quain, in his 36th plate, fig. 1, (Series of Anatomical Plates,) represents the vein on the inside of the biceps tendon, uniting itself to the median cephalic and basilic, there being no median superficial vein, which, as in M. Velpeau's case, does not agree with the description of these vessels found in their own books. M. Blandin, in his plate, has also given a poor and imperfect delineation of this vein, plates xvi., figs. 1 and 2. M. Bourgery, in plate 61 of his great work on anatomy, has given a very confused drawing of this vein, which he calls "the anastomosing branch of the confluence of the superficial and deep-seated veins." M. Malgaigne, like MM. Blandin, Berard, and Velpeau, considers this a superficial branch, which springs from the "*two median cephalic and basilic veins, and empties itself into the humeral artery.*" Our author seems to have written this work in great haste, which accounts for his not correcting this singular mistake of *artery* instead of vein. See Op. cit., p. 444, tome ii.

There are several interesting points regarding the situation of the veins of the arm worthy of the surgeon's attention, and which are generally neglected. These large veins always pass over the front of this region; are more or less concealed by fat, and lie under a superficial fascia of cellular substance which sometimes is pretty thick and always loosely connected to the aponeurotic membrane enveloping the fore-part of the limb; for this reason they are not strictly subcutaneous: M. Cruveilhier[1], however, conceives that the median basilic vein frequently forms an exception to this rule, and that it "*lies in a great many subjects*" immediately under the skin. There are likewise many precautions necessary in the operation of blood-letting, which are nearly connected with the relative anatomy of the veins. Among the most common accidents which follow blood-letting, we may safely place first, inflammation of the vein and the tissues around it; this inflammation is frequently phlegmonous, and extends some distance above and below the elbow, and may end in suppuration. These accidents cannot often be traced to any negligence on the part of the surgeon; too much care cannot, however, be observed, in closing the opening of the vein with fine linen or sticking plaister, so as to prevent any irritating friction upon the edges of the wound. Thrombus and ecchymosis are still of more frequent occurrence, but they scarcely merit notice.

Surgeons formerly supposed that there was much danger to be apprehended from wounding the aponeurotic fascia of the arm and the tendon of the biceps muscle. They attributed many symptoms to such injuries which pathologists now ascribe to the pricking or the dividing of the nerves. It is therefore of importance to inquire whether there be any means of preventing those accidents. The nerves most liable to be punctured or divided in bleeding at the arm, are, the musculo-cutaneus internus, the small twigs of Wrisberg's intercostal nerve, which follows the basilic vein and loses itself in the integuments, the musculo-cutaneus externus, the median nerve, and the radial nerve. I have made repeated dissections of the nerves with a view of comparing their relative situations with respect to the veins; the result of these investigations is, that the internal musculo-cutaneous nerve is as irregular in its divisions as in its situation; it sometimes passes in front, sometimes behind the veins, sometimes on their inside, sometimes on their outside; sometimes its branches run towards the middle or even to the outside of the arm, when it generally anastomoses with the external cutaneous nerves; sometimes no anastomoses take place between these two nerves until they reach the fore-arm[1]. Camper has given a very correct delineation of these nerves, which he does not make anastomose at the bend of the arm, and I am inclined to consider this the most common distribution. Neither does M. Lebaudy, in his plates, show any anastomoses between these nerves, which are about twice too large, *although* that author call his drawings "*de grandeur naturelle.*" M. Velpeau[2] represents no anastomosing branches, and places the cutaneous nerve on the outside of the basilic vein; in his book, however, (page 420,) this nerve is described "as being enclosed in the same sheath with the basilic vein, *and almost always on its inside.*" M. Gerdy[3] says that "the cutaneous nerves are always liable to be injured by the lancet, owing to the anastomoses between the internal and external cutaneous nerves; this accident produces instantaneous and acute pain, which extends to the fingers." We cannot agree with M. Gerdy, who seems to consider the anastomosing nerves as being generally wounded; nor does it appear necessary that acute pain should follow immediately their injury, a point which further observations will explain. The same distinguished writer likewise maintains that there is greater danger of puncturing the nerves, the nearer the lancet approaches the sides of the arm; an opinion which our dissections do not corroborate. We think it may be established as a general principle, that there is less risk of wounding the internal cutaneous nerve, the nearer the lancet punctures the centre of the basilic, median basilic, and cubital veins, in a parallel direction with those vessels. This will appear evident by casting a glance over the little sketch of these veins and nerves which we have given, and where the ordinary course of the nerves may be observed running mostly alongside and in the same direction as in the veins. The external musculo-cutaneous nerve is very regular in its situation, and almost always lies on the outside of the biceps tendon, behind the cephalic vein, or perhaps more frequently on its inner side; however, as it proceeds towards the "vena communicans," where it divides into several branches, it mostly passes on the inside of this vein. M. A. Berard, on the contrary, says it passes on the outside of the vena communicans. See p. 214, Dict. de Méd. cit.

I have also found this nerve on the outside of the vein; I have never seen it pass in front of the median cephalic vein; and as it is deep-seated and regular in its course, the best way to avoid cutting it, in bleeding that vein, is to open the vein in its middle, taking care not to plunge the lancet too deep, lest it should run through and through the vein, and injure the nerve behind it. M. Velpeau[1] says, "That the cephalic vein is *accompanied on its side* by the external cutaneous nerve, and for some bad reasons states, that nervous accidents are less to be feared in opening this vein than the others; however, further observations will prove that such accidents occur here as well as in the basilic veins, which anatomy easily explains; and it is difficult to believe that M. Lisfranc[2] should affirm that the median cephalic vein is the most advantageous for bleeding, because he never found any nerves near it. M. Gerdy adverts to the danger of wounding the radial nerve in very thin persons, while, on the contrary, M. Velpeau[3] says, "This nerve is separated from the humeral artery by the whole thickness of the brachialis anticus and biceps muscles, and sufficiently distant from all the veins to run no risk of being wounded in venesection." This nerve may certainly be injured in very thin subjects; but in order to effect this, the operator must thrust his lancet into the vein in a most imprudent manner. The median nerve has sometimes been wounded by careless and ignorant phlebotomists, in the same way that the brachial artery, which lies by its side, has been opened. The use of a broad-pointed lancet is the most effectual means of preventing this accident.

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[1] Page 300, tome iii. Anatom. Descript.

[1] See Fig. 108.

[2] See Fig. cit.

[3] Anatomie des Formes, p. 186.

The injury of the cutaneous nerves, which probably often occurs, is not always followed by accidents, if we may judge from the fact of their being rarely observed; such cases, however, do sometimes present themselves, and may cause great pain to the patient, and considerable injury to the reputation of the surgeon, although he ought not, perhaps in the majority of cases, to incur any blame whatever. In a chapter "on the injury of the nerve in bleeding," Mr. C. Bell[4] says, "The convulsive attacks, and the clenching of the jaws *in violence, seem to bear no relation* to the state of inflammation in the wound. They are even greatly aggravated after the healing of the wound." This last assertion is confirmed by three interesting cases which Dr. Valentine Mott has kindly communicated to me, and which he intends publishing. Dr. Mott calls this affection of the arm "traumatic neuralgia:" it appears some time after the simple operation of bleeding, and is explained by a branch of the cutaneous nerve being involved in the cicatrice of the vein, and thus probably pinched or tightened by it. Dr. Mott cured these three patients by a neat removal of the cicatrice. In one instance this talented surgeon traced a twig of the nerve into the excised cicatrice. Several similar examples are also recorded. Scarpa[5] has described many cases in his "minor works" on surgery, to which we will briefly allude, as they are never quoted, although from the pen of so elegant and learned a writer. Scarpa asks the question whether these "terrible neuralgic affections" may not be explained, by the lancet or other body, in wounding the nerve, making an opening in the covering or neurilema through which the pulp of the nerve protrudes, is strangled, inflames, becomes hard, and enlarges! Scarpa quotes, from the authority of Pouteau, the case of a nun who was bled in the foot; a small hard cicatrice followed the puncture of the vein, which was the seat of most acute and constant neuralgia: the pain extended up the leg, thigh, and to other parts of the body. Pouteau made a crucial incision in this cicatrice, but to no effect; the cicatrice having been removed, the patient was instantly cured. Scarpa saw a somewhat similar case in 1811. A peasant woman was pricked in the leg by a thorn, the wound healed quickly, but soon became the seat of excruciating pain, which extended up the thigh and arm; this neuralgia had already existed ten years. Scarpa found a small hard cicatrice in the situation of the puncture, which was acutely painful to the slightest touch; from its situation, he considered the saphena nerve to be the cause of this severe affection; the cicatrice was removed by Professor Jacopi, and upon examination was found to contain a nervous filament, which was compressed and disorganized by this hard cicatrice. The patient was instantly cured. Scarpa was consulted by Signor Mondella for a neuralgia of the arm, which followed venesection: in this case the pain extended to the thumb and fore-finger and to the scapula, and was so intense, that it deprived him of rest by night as well as by day. Scarpa discovered a small, hard and prominent tumor where the lancet had opened the vein; pressure "upon this little tumor produced excruciating pain as rapid as an electric shock." This gentleman objected to having the part removed by the knife; caustic was therefore used, which finally put an end to this most violent neuralgia. According to Scarpa, that estimable surgeon, M. A. Petit of Lyons, cured a young lady of a similar affection, by the application of caustic to the cicatrice. Pott used to mention, says Mr. S. Cooper[1], two cases of distracting pains following bleeding: "he recommended the total division of the nerve, which he supposed was partially divided by the lancet. Dr. Monro relates similar cases in which such treatment proved successful." Mr. Swan[2] relates the case of a lady who for two days was in convulsions produced by acute pain following bleeding at the arm. Dr. Wilson, who attended this patient, made a transverse incision through the part punctured by the lancet, which, not being sufficiently deep, gave no relief; another transverse incision above the first succeeded in dividing the injured nerve, and the patient immediately exclaimed, " I am cured!" Bosquillon, in his notes to Bell's Surgery, mentions two cases of neuralgia of the neck, following bleeding in the jugular veins. I have heard of similar cases occurring after venesection in the saphena vein. Ambroise Paré has given an interesting account of acute pain produced by the lancet, which occurred in the person of King Charles the Ninth of France, who was bled by an expert operator, and " who, thinking to open the vein, pricked the nerve, which quickly made the king cry out, saying, that he felt a very great pain." The arm was immediately contracted, and could not be unbent for three months. Before we leave this subject, and to show how imperfectly it is treated even by the most recent authors[1], we give the following quotation[2]: " The wounds of tendons do not deserve notice, nor even those of nerves; the former can scarcely be wounded in the operation (of bleeding), and would not in all probability, if they were, lead to any bad consequence; the partial division of branches of the cutaneous nerves has given rise to painful feelings in the limb, and to general disturbance of the nervous system. Such occurrences are rare, may be treated by general means, or, if need be, the original wound may be slightly enlarged. No regular dissection of the bend of the arm, as has been proposed, can ever be warranted." Notwithstanding this authority, after the facts we have stated in this paper, the reader will be convinced that the biceps tendon is easily wounded by the lancet, and that the nerves " deserve notice." Mr. Liston himself shows, that enlarging the wound is a very imperfect treatment; and that without making " *a regular dissection of the bend of the arm*," the cicatrice or wound should be removed, or the nerve divided transversely across and above the puncture.

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[1] Anatomie Chirurg., tome ii. p. 419.

[2] See Malgaigne's Op. cit., p. 442, tome ii.

[3] Op. cit., p. 424, 5.

[4] A System of Operative Surgery founded upon the Basis of Anatomy, p. 68. London, 1807.

[5] Opusculi di Chirurgia, vol. iii. p. 18. Pavia, 1832.

[1] Surgical Dictionary, p. 239.

[2] On Morbid local Affections of the Nerves. See also Scarpa and Descot for this case.

If the lancet be plunged too deep, the vein may be pierced through and through, or the blood may escape from both apertures, and thus cause extravasation, which, owing to the superficial cellular fascia, will not be apparent outwardly by any redness of the skin, as in common ecchymosis produced by the blood flowing into the cellular tissue, and when the puncture in the skin is too small, or is not parallel with the incision of the vein. I have lately dissected the arm of a man who was bled a few days before his death, in which there were no outward signs of extravasation of blood; but upon examination, a quantity of blood was found under the superficial cellular fascia, and extended principally along the median basilic vein, to the aponeurotic canal of the communicating vein, where it seemed to pass beneath the aponeurotic fascia as far as the insertion of the biceps tendon into the radius, and surrounded also the deep veins. Careful inspection showed that the median basilic vein had been transpierced by the lancet; coagula were still adherent to the posterior opening of the vessel; the fascia tendinosa of the biceps muscle did not exhibit any corresponding wound; therefore it is highly probable that the venous blood, in flowing out behind the vein, was kept down by the cellular tissue and superficial fascia, and thus found its way to the vena communicans, and hence to the deep veins.

There can be little doubt that the veins of the arm must frequently be transpierced by the lancet, and that more or less blood may pass into the cellular tissue beneath the superficial fascia, and in this manner escape discovery; those pains which are frequently produced by the slightest motion of the elbow after bleeding, may be thus explained. Sometimes also a slight swelling in the neighbourhood of the puncture of the lancet is discernible, and can easily be accounted for by admitting this double division of the vein, which we think will be best avoided by making use of a very sharp and broad-pointed lancet.

The next parts to be described are all covered by the aponeurotic fascia, which cannot be completely understood until the biceps muscle is considered: this membrane however presents many irregularities in different situations; hence it is strongest on the inner side of the bend of the arm, where it generally receives a considerable addition from the biceps tendon; after which it spreads over the pronator and flexor muscles of the fore-arm, and subdivides into distinct sheaths, which confine them in their proper place, and give them support during their contraction. The knowledge of the existence of these sheaths is of great importance, for it explains how matter may be present without forming any tumor, but being kept down by their fascia may extend along the fore-arm; and hence also the necessity of opening them as soon as suppuration appears to have commenced. On the outer side of the biceps tendon, this aponeurosis is reduced to a fine transparent membrane, which, owing to its extreme delicacy, does not seem to cover the tendon; nevertheless it passes over it, and then behind the cephalic vein and musculo-cutaneus externus nerve, where it unites to the fascia given off from the brachialis muscle, which covers the outer or radial eminence.

The muscles which are found in this region of the arm are interesting to the surgeon, and a knowledge of them can alone account for many facts regarding fractures and dislocations. The biceps muscle forms the upper and anterior projection of the bend of the arm; it terminates in a strong tendon, which is somewhat twisted upon itself, and is finally inserted along the posterior edge of the tubercle of the radius, and not, as many anatomists assert, upon that process itself. The fibres of this muscle end very variously in its tendon, which explains the diversity of forms in this part. Sometimes the lower border of the biceps is of a convex form, but more frequently it is more of a triangular one, the middle muscular fibres extending lower down than the lateral ones; the tendon begins higher up the arm on the outer than on the inner side; the outer side of this tendon is always regular in its form and presents a smooth rounded edge. At the inner side, on the contrary, great diversity is observed; thus, sometimes the inner fibres are inserted into the common tendon; at other times they end by a number of small and separate tendons, which are inserted into the aponeurosis of the fore-arm; when this disposition occurs, the tendinous expansion given off by the biceps tendon, is generally slight, or does not even exist; in which case, there is no semilunar fascia, such as is described and delineated by Cowper, Camper, Langenbeck, Tiedemann, Cloquet, Bell, Blandin, Velpeau, Gerdy, Bourgery, Quain, &c. The first good description, and tolerably correct drawing of this tendinous expansion, was given by W. Cowper[1], who called it "fascia tendinosa," and did not restrict its use to the "*more advantageous elevation or bending of the cubit* (fore-arm), *but it also corroborates* (strengthens) *the muscles in those strenuous actions they are necessarily employed in.*" This fascia lies immediately over the brachial artery, and requires careful division when that vessel is to be laid bare. This expansion is united to, and in a great measure forms, the common sheath of the muscles in front of this region; it also principally constitutes the aponeurotic opening for the "vena communicans," which is somewhat enlarged by the action of the biceps muscle, which, by means of the fascia tendinosa, is a "tensor" of the aponeurosis of the fore-arm. This tendinous fascia is generally inserted (or given off) obliquely across the tendon of the biceps muscle towards its outer edge. The biceps tendon, after receiving or giving off this aponeurotic fascia, proceeds downwards through the triangular space left between the inner and outer muscular eminences (pronator and supinator muscles); in this course, it is twisted upon itself, and, like the tendo Achillis, becomes broader before it inserts itself into the posterior border of the tubercle of the radius: many anatomists make this tendon end in the tubercle itself; but this is incorrect. The lower part of this tendon is likewise provided with a bursa mucosa, which enables it to move smoothly over the tubercle of the radius; this synovial sac is formed by a very fine and transparent membrane, covered by cellular and adipose tissue; it extends more than an inch up the tendon and is inserted along its radial side in an oblique and waving line; when blown into, it rises up between the biceps tendon and the lower part of the brachialis anticus muscle; in this state it is in contact with the brachial artery; it also raises up the superior part of the inner side of the supinator R. brevis muscle. It may at first appear singular, why this "bursa" should extend so high up the tendon; it is evident, however, that this lubricating surface is not wanted during flexion of the fore-arm, in which motion the biceps tendon draws the radius directly upwards, and is not in contact with the bony eminence; but, on the contrary, when pronation takes place, then, the biceps tendon presses against the tubercle, and requires the bursa to promote the easy rolling motion of the tendon over that hard surface. This bursa, like all others, may become distended with fluid, and might then present some difficulty of diagnosis, especially if the pulsations of the brachial artery were communicated to it. The biceps tendon becomes prominent during half-flexion of the fore-arm; the fingers may then be almost made to meet underneath it; in certain deformities produced by its violent contraction it might easily be divided by a simple incision, as is done in operating upon the tendo Achillis. In persons whose elbow-joints have been excised, the biceps tendon is extremely prominent; it is, of course, highly important in this operation, to spare, if possible, the insertion of this tendon, which is so valuable in all manual labour, and by whose assistance patients thus operated upon have been able to lift heavy weights, and pursue various avocations, &c.

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[1] Mons. Mondière, Archives de Méd., p. 300, 1837, in his analysis of Mr. Swan's work, very justly remarks, that this subject is not even mentioned in the new Dict. de Méd., and, I might add, many other French productions.

[2] Page 192 of Mr. Liston's Practical Surgery. London, 1837.

For the better comprehension of the muscular parts of this region, we proceed at once to the description of the brachial muscle, leaving the vessels which lie upon it to a future period, on account of these two muscles acting together in various ways and producing very similar effects.

The brachialis anticus (*brachiæus internus, humero-cubitalis*) is a strong muscle which fills up the hollow left between the two condyles of the arm-bone, and partly covers the condyles themselves; the lower extremity of this muscle is of an irregular shape, adapted to its situation, which is uneven. Its outer side is the strongest where a thick tendinous band lies upon the side of the head of the radius; the back or deepest part of this muscle is pretty closely attached to the capsular ligament of the joint, as well as to the coronoid process of the ulna, by means of small tendinous fibres; hence, probably, the very common error of describing "the brachialis tendon as inserted into the coronoid process of the ulna," (Sir A. Cooper, B. Cooper, Jones Quain,) whereas, this tendon is finally inserted into an oblique line below that process, and across the front part of the cubitus, exactly opposite the tubercle of the radius. This muscle generally sends off an aponeurotic expansion which spreads itself over the supinator longus, and thus strengthens the common sheath of the fore-arm; there are sometimes some tendinous fibres which unite themselves to the tendon of the biceps muscle.

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[1] Myotomia Reformata, p. 74.

The brachialis muscle, by filling up the hollowed surfaces between the condyles of the arm-bone, gives a more regular form to this region ; nevertheless, the inner half of the lower end of the humerus, which extends lower down than the outside one, presents also a more prominent surface, called trochlea ; this projecting surface being covered by the brachial muscle and pronator radii teres muscle, constitutes in a great measure the inner eminence of the arm which has been incorrectly attributed to the flexor muscles of the fore-arm, which scarcely contribute to its size, owing to their superior origins being comparatively small, pointed, and tendinous ; this projection is much larger in the male than in the female, on account of the greater muscular and osseous development. When the biceps and brachialis muscles act together, the fore-arm is bent upon the arm, and each giving aponeurotic fibres to the common sheath of the limb, must alike be considered tensors of the aponeurosis. When the biceps contracts slightly, its tendon becomes more prominent, the furrow at the bend of the arm disappears ; the brachialis muscle being intimately attached to the capsular ligament does not rise forward like the biceps tendon, and hence it produces but little visible change in the form of this region, when put into action. In fractures and dislocations, these two muscles may perform various offices ; if the neck of the radius be broken, the biceps will displace the lower fragment of the fractured bone and thus prevent its union ; if, on the contrary, as is commonly the case, the radius be fractured below the tubercle of the radius, the biceps by its contraction may draw the upper fragment of bone forward ; thus, it is quite wrong to lay down as a general rule, that in fractures of the superior third of the radius the biceps draws the upper fragment forwards. The brachialis muscle may act in a very similar way as regards fractures of the ulna and its coronoid process ; if the coronoid projection be alone broken off, this muscle, being inserted below it, may keep it down and prevent any displacement occurring ; and also render the diagnosis somewhat difficult ; may not this be the cause of such fractures escaping detection ? If the coronoid process be fractured with a small portion of the upper part of the ulna, situated below the insertion of the brachialis tendon, then, this muscle will pull up the superior extremity, while the triceps will tend to draw the olecranon upwards and backwards, and thus produce dislocation of the humerus forwards, or the ulna alone, backwards, which is most commonly the case. From not attending to the exact situation of the insertion of the brachialis tendon, a common mistake has likewise arisen, that when "the coronoid process of the ulna is broken off, there is nothing to counteract the action of the triceps muscle, and the ulna must be drawn backwards and upwards ;" this will evidently occur when the coronoid process is separated from the ulna below the insertion of the brachialis muscle.

In luxations of the radius backwards upon the external condyle, or upon the side of the olecranon, which I believe is the more common case, the biceps, by contracting, may considerably increase the displacement and cause the head of the radius to press against the skin, where it is almost destitute of adipose tissue, and may easily produce its mortification. The action of the biceps muscle will also tend to increase the displacement of the head of the radius in its luxations forwards upon the pulley-like surface of the humerus, and probably in part prevents dislocation of the radius upon the coronoid process taking place, owing to its contraction drawing the bone immediately upwards ; besides, the thick end of the brachial muscle also prevents the head of the radius from lying upon this part of the ulna ; nevertheless, some surgeons seem to think that this sort of dislocation is frequently met with. I have examined several specimens of luxations of this bone, but have not yet seen this sort of displacement. In luxations of the humerus forwards it is principally the brachial and biceps muscles which limit its displacement, and offer an impediment to the extremity of the bone passing down the fore-arm, or through the integuments ; in this action, these muscles may be opposed by the violent contractions of the triceps, which by pulling up the cubitus will increase the displacement of the humerus ; hence in these dislocations, the biceps tendon and brachial muscle are put upon the stretch, especially the latter (a few fibres of which are probably always lacerated), as may be seen by referring to a drawing (plate 24) of it in Sir A. Cooper's work on dislocations. Sometimes, however, the violence of these injuries is so great that the muscles no longer bar the progress of the humerus ; they are torn through ; the bone still advances, tears through vessels and nerves, and finally protrudes through the integuments. The annals of surgery record several such cases, and M. Cruveilhier has lately published (p. 8, Fasciculus ix. of his Anat. Patholog.) a similar observation of an English lady who, falling from her horse, on the palm of her hand, sustained a compound luxation of the lower end of the humerus forwards ; the end of the bone protruded ; the brachial artery and veins were ruptured, which caused violent hæmorrhage and syncope ; nevertheless, the bone was reduced and the patient recovered. It is almost needless to observe how very important it is, in excision of the elbow-joint, to avoid if possible cutting away the insertion of this muscle.

The brachial muscle, which is closely connected to the capsular ligament by means of small tendinous fibres, may be partly considered as a ligament to the joint, which perhaps also explains the reason why the anterior part of this articulation should be apparently so weak.

Between the biceps and brachial muscles there is mostly a quantity of cellular and adipose tissue which surrounds the artery, veins, and median nerve; this substance sometimes becomes inflamed, giving rise to deep-seated abscess, which requires peculiar caution in opening, on account of the number of vessels in its vicinity. The brachial artery lies upon the inner and anterior surface of the brachialis anticus muscle, on the outer side of the median nerve, which at the bend of the arm is not very close to it, owing to that nerve passing more inwardly to dive under the pronator radii teres muscle. The artery passes downwards towards the radius along the triangular space found between the outer and inner muscular eminences, and on the inside of the tendon of the biceps muscle; when about two inches below the tuberosity of the inner condyle of the humerus it divides into the radial, ulnar, and interosseous arteries, which will be described elsewhere. This artery is accompanied by two veins called the satellite veins, or venæ comites, or deep humeral veins; one of these vessels generally passes over the front of the artery near the middle of the bend of the arm. This artery is first partly covered by the inner border of the biceps muscle, a little lower down by its tendon, and "fascia tendinosa;" by branches of the internal musculo-cutaneous nerve; by the median basilic vein; by lymphatic vessels; by the superficial cellular fascia; by a layer of adipose substance; and, lastly, by the integuments; of these different parts the most important in a practical point, are the basilic vein and biceps tendon. The humeral artery is generally described as being crossed by the basilic vein at the middle of the bend of the arm; therefore, M. Gerdy, like many other writers, says, there is much less danger of wounding the artery when bleeding that vein, above and below, than in the middle point; frequently, however, the artery takes exactly the same course as the vein; but even then, there is in fact more danger of wounding the artery in this middle part, on account of its passing over the most prominent point of the brachialis muscle, causing it to be more superficial, and less likely to escape injury, that muscle presenting a resisting surface; whereas, if venesection be performed lower down in the same vein, there is much less risk of puncturing the artery, because it lies deeper, and is also more protected by the biceps tendon and fascia; nevertheless, it is always imprudent for the surgeon to open the vein in the course of the artery, a subject which we must touch upon presently, as it presents much interest. This artery can always be felt pulsating at the bend of the arm; the operator should always examine this region very carefully before bleeding or cutting down upon the artery, on account of the frequent irregularities which that vessel presents; surgeons have often been much puzzled at meeting with these anomalies, during their operations, of tying the brachial artery, but in many cases a minute inspection of the limb might have previously put them on their guard.

For a knowledge of these varieties of the artery, the reader must refer to the works of Meckel, Harrison, Tiedeman, and my friend P. H. Green's interesting little book "On the Varieties of Arteries." All anatomical museums contain preparations of such cases; several are mentioned in Dr. Hodgkin's excellent catalogue (sect. iii.) which is a most praiseworthy example to all professors of anatomical collections, which at present are of very limited utility, owing to their being so little known to the profession at large; we hope to see the former taste of giving splendid representations of interesting preparations which are concealed in cupboards, revived; the labours of Ruysch, Sandifort, and Fred. Meckel, show that the subject is not unworthy of great minds.

Notwithstanding the great diffusion of anatomical knowledge, this artery[1] is still sometimes injured in "bleeding" at the arm by ignorant or incautious operators; the result of this wound is almost always an aneurism, of that kind called "false diffused, false circumscribed," or both these together; or of that kind termed varicose aneurism, which may also be accompanied by one or both of the two former. As this is a point of great practical importance, and as we possess an observation of this disease, which is badly understood, we cannot refrain from publishing it, hoping it may throw some light upon an obscure affection, and elicit further observations.

This species of aneurism was first clearly pointed out by Dr. William Hunter (in 1757 and 1762). This celebrated man was too modest to attach much importance to the name of this disease,—"whether it should be called an aneurism or a varix, or both or neither." It would appear[2], however, that he named it, "*aneurism by anastomosis, being caused by an anastomosis or communication of the vein and artery.*" George Cleghorn, professor of anatomy in Dublin, was the next person who distinguished this sort of aneurism. In a letter to W. Hunter, Cleghorn gave a very good account of a case which occurred after bleeding, in the arm of a boy aged seventeen. Cleghorn proposed calling this disease aneurismal varix. In describing the symptoms of this affection, he lays great stress upon the thrilling sensation and hissing noise which are perceived by placing the ear upon these aneurisms, or by applying one end of an iron rod, or catheter, to the tumour, and the other to the ear; this is probably the first time "mediate auscultation" was ever used to facilitate the diagnosis of aneurisms. Cleghorn likewise enriched his letter with an engraving which portrays the dilated state of the basilic, cephalic, and median veins [1].

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[1] Formerly this accident was of very frequent occurrence. Dionis tells us, that "a celebrated surgeon, whose name is much respected among us, and who was most skilful, and had acquired greater fame *for bleeding* than was ever possessed by any other phlebotomist, confesses to have opened the brachial artery eleven times in the course of one year (before 1716); a misfortune which he could not avoid, says Dionis, because he was called to so many difficult cases."—Huitième Démonstration Anat. p. 593, 4.

[2] See S. Cooper's Surg. Dict.

These valuable observations had not probably reached foreign shores, when Guattani, of Rome, published a good memoir upon aneurisms, in which he describes this new species; hence, some persons, totally ignorant of dates, have endeavoured to rob British surgery of one of its numerous glories; however, Guattani [2] saw his first patient in 1769, and his second in 1771. He published his paper in 1772; it is, therefore, surprising that the learned Monteggia [3] should have written, "*that this disease was first described by Guattani, then by W. Hunter, to whom improperly is attributed the discovery.*" As a corroboration of this statement, Monteggia refers to Arnaud's Mémoires, where the reader may search in vain even for Guattani's name. Scarpa, on the ground that Guattani was ignorant of Hunter's papers, is anxious to claim an equal share of merit for his countrymen, which impartial history will not grant.

Of all the forms of aneurism, this one is doubtless the least understood. Opportunities of investigating the morbid condition of the parts affected rarely occur: few authors, therefore, have been enabled to give a tolerably correct history of this affection. The majority of surgeons prefer leaving the disease to nature, or, when they do interfere, operations are performed which not only disturb the relative situations of parts, but likewise destroy their integrity: hence, should the patients eventually sink under the operation, very little can be learnt by anatomical inspection: for these reasons, therefore, we must not be surprised that many opinions concerning this disease should be founded on erroneous or conjectural grounds. To save time, we shall at once draw the following conclusions, from the most approved and recent authorities, which will show at a glance the state of science upon this subject.

Varicose, or arterio-venous aneurism generally occurs after bleeding at the arm, and is caused by the lancet running through both sides of the median basilic vein, into the brachial artery which lies beneath it; the external wound of the integuments and vein heals up, while the puncture through the opposite side of the vein remains open, and receives more or less blood from the injured artery. These are considered the necessary conditions of this sort of aneurism; and the consequence is, that the superficial veins of the arm become "varicose, aneurismal, and pulsate." These views, which were first established by W. Hunter, have been followed by Scarpa, Hodgson, Delpech, Roux, Dupuytren, Bell, Wardrop, Breschet, Liston, &c. This sort of aneurism has likewise been detected in other parts besides the arm, as the axillary, subclavian, carotid, femoral, and popliteal vessels; nevertheless the same explanation has been given; the veins have always been supposed to have been divided through and through. These additional examples prove that varicose aneurism may exist between deep as well as superficial veins and their corresponding arteries. It must notwithstanding be recollected, that all the cases of varicose aneurism produced by bleeding at the arm, have invariably been represented as existing between the superficial median basilic vein and the brachial artery. I know but one exception, namely:—Park's case of aneurism, mentioned in J. Bell's work, which could not be explained by that author, and was consequently considered, and called, "an anomalous case of aneurism."

The object of these observations, is to demonstrate, that varicose aneurism and aneurismal varix may be produced by the lancet injuring the deep veins and brachial artery. We have been fortunate in having an opportunity of dissecting a limb affected with this peculiar form of aneurism; and from the case being ripe with interest, it appears a duty to communicate the principal facts connected with it. The case is such as seldom finds its way into print, unless when persons are actuated by the lowest motives; and I beg the reader will reflect, that I am indebted, for the dissection of this limb, to M. Roux, whose friendship I prize as much as I admire his scientific and high-minded character.

The patient was a female about thirty-five years of age, of delicate form; during an illness she was bled in the arm by a female friend; the artery was opened; a tumor or circumscribed false aneurism, with all the symptoms of varicose aneurism, was the consequence. M. Roux saw the patient soon after this accident, and decided upon giving J. Hunter's operation a trial, for the cure of this double form of aneurism. The brachial artery was therefore tied at about the middle of the arm. The tumor, or circumscribed false aneurism, disappeared after this operation; the varicose aneurism, however, still continued; and the patient left the Hospital of "La Charité." The disease made slow but gradual progress. This unfortunate female now applied to MM. Dupuytren and Lisfranc for relief; but these gentlemen preferred "*doing nothing*." The pain in the arm, the increasing weakness of the limb, with its gradual emaciation, and its distressing whizzing noise, at last drove the patient to the resolve of having something done; she returned once more to M. Roux, full of courage, and determined to submit to any operation which presented the slightest hopes of alleviating her sufferings. She was admitted into "La Charité" in 1834, which was about three years after the trial of the Hunterian operation. I saw this patient but once, and on the day of the operation; the arm was very painful, and much smaller than the healthy one; the superficial veins (cephalic and basilic) at the bend of the arm were very large and varicose, and pulsated as far as the middle of the upper arm; these pulsations were visible to the eye; the peculiar whizzing noise and thrilling sensation were extremely well marked. At the middle of the upper arm a long cicatrice existed, where the artery was formerly taken up; at one point of this cicatrice the pulsation of the vessel entirely ceased; several smaller cicatrices, evidently the result of repeated venesection, were discernible at the bend of the arm, a circumstance of some importance, as their existence (together with a tumor formerly in the same point, which must have produced some disturbance in the exact relative situations of these parts), must make it difficult to point out the precise spot where the artery had been punctured. M. Roux now determined upon cutting down to the brachial artery at the bend of the arm, and applying a ligature upon it both above and below the point where this vessel communicated with the vein which was supposed to be the "median basilic." I assisted M. Roux in this terrible and perplexing operation. He endeavoured to put a ligature round the artery, first, immediately below its wound. In proceeding towards this step, a large superficial vein was cut (probably the median basilic), which poured forth its blood in great profusion: compressing the artery did not entirely arrest it: the quantity of blood gushing out of this vein at each pulsation of the artery determined M. Roux to pass a ligature round it by means of a curved needle, taking all precautions to avoid any other surrounding parts, &c. M. Roux again proceeded towards the artery, but every incision of the scalpel was followed by a fresh hæmorrhage; the patient complained of acute pain, and the wound was constantly filled with blood; for these reasons the operator abandoned the idea of laying the artery bare, and, feeling for it with his finger, he was soon satisfied that he could distinguish its pulsation: he then plunged a curved needle and ligature immediately beneath his fingers, and tied the artery tight: from this mode of proceeding, other parts besides the artery were necessarily exposed to being included in the ligature. The operator believing that the lower extremity of the artery immediately below its communication with the vein was now secured, fancied this single ligature might suffice; this was in fact reasoning on the Brasdorian principle. M. Roux appealed to me. I put my fingers upon the brachial veins, which pulsated with their wonted force: the idea, therefore, of leaving the patient in this state was immediately rejected. M. Roux now proceeded to take up the artery above its point of union with the vein, the exact situation of which was very difficult to ascertain. Scarcely had the knife been again resorted to, but another large pulsating vein was wounded, which caused profuse bleeding, and was secured by the needle and thread, as before. The dread of further bleeding from the use of the scalpel (which was perhaps too freely used in this perilous operation), prompted the operator to employ it no longer; he therefore again resorted to the curved needle and thread, by which he finally embraced the artery: the tightening of these ligatures produced considerable pain. It was now fully believed that the artery was tied both above and below its wound; nevertheless the pulsations at the bottom of the incision and in the veins were still very strong. In this perplexing state of things, which could not be accounted for, the surgeon's ingenuity and knowledge were completely at a stand; in despair of further benefit, he brought the lips of the incision together, having previously filled up the bottom of the wound with some charpie (French lint), and the patient, extremely exhausted from pain and loss of blood, was conveyed to her bed. Several hæmorrhages occurred the following days; the arm was still very painful; the veins pulsated forcibly; and the dread of fatal hæmorrhage led M. Roux to amputate the upper arm at about its middle. The unfortunate sufferer survived this operation only a few days. M. Roux kindly gave me the amputated limb to dissect, but owing to the various wounds made in the superficial veins, and also to the destruction of parts by suppuration, it was impossible to give a correct view of the more superficial organs; we took a sketch of the deeper parts, which we hope will be sufficient to explain the peculiarity and the extreme difficulty of this case, and also be a warning to surgeons in future how they undertake an operation so hazardous for the patient, and so perplexing for the operator.

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[1] John Bell's introduction of the terms "aneurism by anastomosis" to denote "nævus maternus;" and the distinction which some writers draw between aneurismal varix and varicose aneurism, have already created some confusion in this point of nomenclature. To avoid all ambiguity, MM. Dupuytren and Breschet prefer the name of arterio-venous aneurism, or aneurism by transfusion; we shall employ the word "varicose," which is generally understood, and means, properly, an aneurism formed by the communication of the artery and vein; the "aneurismal varix" is a distended state of the veins which pulsate like arteries, and is the consequence or extension of the varicose aneurism which frequently exists alone.

[2] De Spurio Brachii Aneurysmate, p. 223, 224. See Louth's collection of Theses.

[3] Instituzioni Chirurgiche, p. 183. c. i. Milano, 1829.

By casting a glance over the sketch, the following particularities will be observed.

This was a perfect example of varicose or arterio-venous aneurism, and aneurismal varix, exactly similar, in outward appearances and symptoms, to the disease first pointed out by William Hunter, and first delineated by Cleghorn: it was likewise considered such by all the surgeons who saw it. It differed, however, in this respect, that the communication did not exist between the median basilic vein, or superficial vein, and the artery, as all authors affirm, but between the brachial artery and one of its accompanying satellite or deep-seated veins, resembling those cases of varicose

Fig. 109.

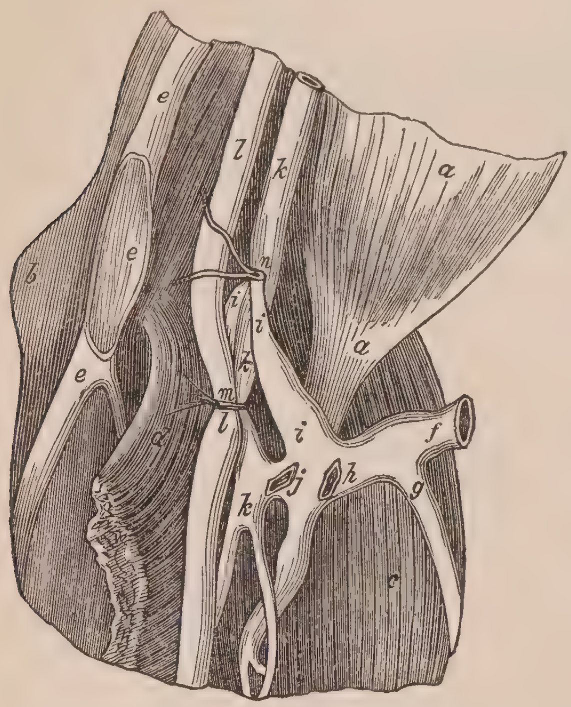

Fig. 109 *represents the front and deep region of the elbow of the left arm. a a, The biceps muscle and its tendon, both placed sideways. b, The tuberosity of the inner condyle of the os humeri. c, The supinator R. longus muscle. d, The pronator radii teres divided, and thrown aside, to allow of the vessels being seen. e e e, The basilic vein partly cut away, where probably the median basilic vein joined it. f, Probably the median cephalic. g, The radial vein. h, The "communicating vein" much enlarged and springing from an enormous satellite vein, i; this "vena communicans" is in a direct line with the canal which existed between the brachial artery, and its deep accompanying vein; j, marks the point, where this canal has been laid open to show it more fully. Close to the letter h is another aperture, where, probably, some enlarged vein was cut away. This sketch shows most distinctly that the superficial veins of the arm became varicose, and aneurismal, by means of the "vena communicans." i i, The satellite veins (venæ comites), which decreased as they became more distant from the wound in the brachial artery; they have been removed at the point where the ligature (n) surrounded them, not presenting any remarkable feature. j, At this canal, between the artery and deep-seated vein, it was impossible to say where the artery began or ended; it was like a perfectly new vessel, existing naturally between the vein and artery. k k k, The brachial artery with its lower division into radial and ulnar arteries which were extremely small, thin, and more like veins. l l, The median nerve which was tied with the artery (at m) at the first step of the operation. n, The second ligature which traversed the artery, merely taking in about two-thirds of its circumference.*

aneurism which are sometimes seen between the femoral, carotid, and axillary arteries and their corresponding veins, &c. several examples of which are already recorded in the annals of surgery. It is probable that the lancet passed through the median basilic vein, then through the satellite vein, and finally into the artery, making thus no less than five openings in these vessels; viz. two in the median basilic, two in the satellite veins, and one in the artery, which may also have been pierced through and through; making in that case six apertures in those vessels. The superficial veins, principally the basilic and cephalic, were extremely varicose, apparently owing to the free anastomosis established between them and the deep-seated veins, by that important trunk the "vena communicans." By the assistance of this vein, the blood propelled by the artery into the satellite vein would find less difficulty in passing directly into the superficial veins, which are larger, and perhaps more easily dilated than the deep-seated veins, than it would experience in distending the venæ comites, or satellite veins, which are considerably smaller. This observation also proves that the artery becomes dilated above the injury, and diminishes in size below it, where its trunk, as well as its branches, partake more of the appearance of veins than of arteries; a fact which is given as a novelty by M. Breschet, but which is distinctly mentioned in several places by his predecessor, P. Adelmann, to whose interesting memoir we shall presently refer. This diminution of the artery below the wound is easily accounted for, by that general law which holds in pathology, that when an organ no longer fulfils its natural function, it diminishes in size, or wastes away: here, the arteries below the wound receive very little blood, and therefore have scarcely any labour to perform, while, on the contrary, the veins having much more to do, increase in size and thickness, and appear *arterialised.* The blood which ought to pass on to the extremity of the limb stops half way, and returns by the new and unnatural canal between the artery and the vein, which is a sufficient explanation, according to Delpech, of the wasting away of the fore-arm. This dissection likewise shows:—1. How difficult it is to point out the exact spot where the lancet had pricked the artery; and therefore the proposal of cutting down to that point, and applying a ligature upon the new canal, is not, as is stated, a very easy and simple proceeding:—2. That surgeons may easily be deceived with regard to the precise point where injury has been inflicted on the artery by the lancet, owing to the basilic vein lying over, and nearly corresponding to the situation of the artery and its accompanying veins. It may perhaps, in future, be possible to distinguish when the anastomosis exists between the artery and deep veins, and when between the artery and the superficial veins, by paying particular attention to the exact spot of the greatest intensity of the thrilling sensation and whizzing noise, which will probably appear to come from a lower part than where the cicatrix at the bend of the arm is seen; and also the dilatation of the superficial veins will be the greatest at the point where the "vena communicans" joins the superficial and deep veins together, which is much lower down the fore-arm than where bleeding is performed:—3. That the Brasdorian operation of tying the artery on the distal side of the aneurism would have no chance of success in an old case of varicose aneurism, owing to the free passage of blood through this new and perfect anastomosis:—4. That tying the artery, upon J. Hunter's principle, is decidedly injudicious, and not in accordance with that great man's views, who was induced to tie the vessel at some distance from the disease, lest it should not be in a sound state: in this form of aneurism such fear is almost groundless. This case, with many more mentioned in M. Breschet's interesting paper, proves beyond refutation, that little benefit can be obtained by tying the brachial artery at the middle of the arm. This observation likewise shows, that a ligature placed above and very near the disease may sometimes be ineffectual, especially in an old case, and in which the artery was formerly tied at a distance from the disease; both these causes rendering the collateral circulation in the anastomosing vessels very active. Finally, the result of this operation warns the surgeon of the danger of using the needle and ligature in the dark, or at hazard; since the median nerve was comprised in one ligature, and the brachial artery transfixed by the other.

I cannot finish this important subject without making a few more observations. After having clearly made out this disease by careful dissection, I was naturally astonished that similar cases should not have been described, and felt convinced that they must have existed. I have since that period discovered that two observations of varicose aneurism (between the artery and deep vein) of the arm are upon record, but they have not been duly understood or appreciated. In speaking of varicose aneurism of the arm following bleeding, Mr. Liston[1] makes the following extraordinary assertions: "*But aneurism may form in communication with the vein, and* TWO *cases of this kind are recorded. This is, properly, varicose aneurism, a disease oftener talked about than understood. This form is treated in the same way as the false aneurism in its early or more advanced stages, by ligature at the wounded part, or in the middle of the upper arm.*" It is hard to imagine how this author can only have cognizance of two cases of this kind of aneurism; his reading must indeed be very limited. But what is most surprising is, that Mr. Liston should have added a wood-cut engraving (without explanations) for the better comprehension of a disease so little understood. This drawing is meant to represent a pure case of varicose aneurism, and is evidently copied from J. Bell's work on Surgery, for there is only this slight difference: Mr. Liston has represented all the fingers extended; while in the *original*, two fingers are partly closed. Now this drawing, which represents, according to Mr. Liston, a common example of varicose aneurism, is considered by Bell "*an anomalous case of aneurism*" (Principles of Surgery, vol. i. p. 302.), which he could not rightly understand, and which was from the practice of Park of Liverpool. Messrs. J. and C. Bell both consider varicose aneurism, after bleeding at the arm, to exist between the superficial vein and artery; they however conceive that the lancet may wound the deeper veins. "*These 'venæ comites' also are sometimes struck with the lancet, and then the artery and veins are all* MASSED *together. Perhaps the anomalous case related by Mr. Park of Liverpool was of this nature.*" It is really singular that Park, Bell, and Mr. Liston have not remarked that their engraving represents most distinctly a canal or communication between the brachial artery and one of the satellite veins, which last seems to dilate into an aneurismal sac, and might have been probably the "vena communicans" distended. The drawing proves beyond a doubt, that there was nothing anomalous in this case; it was purely an example of varicose aneurism and aneurismal varix, similar to the one we have been describing. Mr. Liston could not have chosen a worse specimen of drawing for his object; indeed, it is utterly impossible for the student to understand the sketch without any reference, the more especially as Bell and Park could not clearly make out this case, and hence they called it *anomalous;* notwithstanding this, Mr. Liston produces the engraving to illustrate the principal features of a common varicose aneurism of the arm. Although we entertain no doubt that Park's case can be perfectly explained according to the views we have endeavoured to establish, still, as scepticism is a prevailing rule with many readers, I am happy in being able to present another confirmation of most of the explanations now offered. In a recent tour through Germany, I met with a preparation of varicose aneurism (in the small anatomical museum at Würsburg, formed principally by the labours of Hesselback and the Siebolds), which will throw much light upon the present subject. This preparation was made in 1818, by Dr. Hesselback junior: a brief, clear, and good history of this interesting case is found in P. Adelmann's Tractatus Anat. Chir. de Aneurysmate spurio varicoso. Würceburgi, 1821, a work mentioned by Mr. Samuel Cooper, in his bibliographical references at the end of his article Aneurism (See Dictionary of Prac. Surg.); but this erudite author has given it a wrong date, and does not appear to have read it, otherwise he would certainly have been struck with its remarkable contents. This modest production is so little known, that we shall give an outline of the case. This varicose aneurism (and aneurismal varix) existed in the right arm of "Laurentius Drescher," and was caused by the explosion of a gun which was charged with shot: the patient lived twenty years with this aneurism, which was never operated upon. Adelmann has given an engraving of the preparation, which shows that the communication existed merely between the brachial artery and the satellite vein: the median basilic vein became dilated and aneurismal in this case, as in our own, by the ready communication of the deep with the superficial veins of the arm, by the important branch, "the *vena communicans*." This is not our own inference. Adelmann tells us distinctly, "Ibi loci vena mediana pulsu vehemente sanguinis arteriosi ex vena brachiali (the satellite vein) per dictum ramum conjungentem in se irruentis, sacci ad instar est dilatata." We thus possess three cases of varicose aneurism of the arm, existing between the deep veins and brachial artery, and twice caused by the lancet. The cause of the disease is of little consequence; whether it be produced by the lancet, or by shot, the result is almost alike, the symptoms are nearly similar, and the disease equally inconvenient or dangerous. Are we not now justified in hazarding the opinion, that it is extremely probable that many of the cases which have been considered aneurisms of the superficial vein and artery of the arm, have in reality occurred between the artery and the deep veins? In fact, it appears to us almost impossible for any sharp instrument to open the brachial artery, without injuring at the same time the veins which cover that vessel, more or less; and in this case, why should not the blood of the artery flow more easily into the adjoining vein than into a vein situated at a greater distance? We trust that future cases of varicose aneurism will be more carefully examined, as this is the only way of settling these interesting points of surgical pathology.

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[1] See Practical Surgery, p. 177. 1838.

We must now add a few words concerning the best operation for the cure of this kind of aneurism. Surgeons entertain very different opinions upon this important matter: some consider all operations unnecessary; the disease, they argue, does not endanger life; it is merely an inconvenience: others, on the contrary, "treat this kind of aneurism in the same way as the false aneurism in its early or more advanced stages, by ligature at the wounded part, or in the middle of the upper arm." (See Liston, Op. cit.) M. Breschet has taken great pains to show that tying the brachial artery, according to Hunter's plan, is both dangerous and insufficient: he has brought forward a good many instances of such operations performed by Dupuytren having failed; for this reason, M. Breschet is a partisan of the old operation of cutting down to the artery (or sac), and tying it both above and below the part wounded. I entirely agree with M. Breschet in banishing Hunter's operation from the treatment of this disease; but cutting down to the wounded artery, and passing two ligatures around it, requires some consideration. There is an essential difference in operating upon a recent or upon an old varicose aneurism: in the one, the operation may be easy of execution, and happy in its termination; in the other, it may be most laborious in its performance, and most fatal in its results; we even doubt whether the same operation is applicable to both cases. We shall venture a few, perhaps, premature opinions regarding the best operation for this kind of aneurism, in hopes of soliciting further observations from more experienced pens. In recent cases of varicose aneurism, we believe, a cure may be effected by simply applying one ligature above, *but close to the injured* part of the brachial artery. I was requested by M. Carron du Villards to see a patient (a woman, ætat. 55), who had been bled by a young student: the artery was opened, and all the symptoms of varicose aneurism existed. I strongly recommended cutting down to the artery close to the small tumour, and securing it with a thin silk ligature. We performed this operation about a fortnight after the accident. The incision was made above and almost upon the small tumour: the operation was very easy; it gave rise to no bleeding or injury to the veins, and the patient was rapidly cured. M. Breschet objects to tying the artery close to the disease, lest inflammation of the vessel cause the ligature to cut through the artery too soon; but this appears rather a groundless fear. My friend, Prof. Lallemand, of Montpellier, likewise now pursues this plan of operating for varicose aneurism: he has favoured me with the history of a successful operation performed (in 1836) upon the right-arm of a man, aged 34, who had been bled in the median basilic vein, which caused a varicose aneurism. In old cases we should hardly expect a cure from simply tying the artery immediately above the point of injury: in these cases, if an operation is resorted to, it would be best to make a very careful and prudent dissection of the artery, using the knife as little as possible, and to tie it above and below its wound.

Before we describe the muscles of the posterior side of this region, we must briefly speak of other parts which partly cover them: we have elsewhere observed that very little fat exists over the olecranon and surrounding points of this region, which is supplied on the other hand with fibro-cellular tissue, and also with a subcutaneous bursa mucosa. The cellular tissue is stronger, more fibrous or elastic, opposite the olecranon and inner tuberosity of the humerus, to which it connects the skin, as we have already noticed, than in the other situations or depressions of this surface. When the cellular substance is more delicate, it contains a very slight quantity of adipose tissue, is easily inflated with fluid; which accounts for the elbow swelling with such facility in cases of hæmorrhage following divers injuries. This cellular tissue greatly contributes to the free motion of the skin over the olecranon and other bony projections; under this cellular substance, and upon the most prominent part of the olecranon we find the bursa mucosa, which ought to be inflated, to be well studied; it is generally of a globular form, about the shape and size of the human eye-ball, surrounded by cellular tissue, which forms a sort of sheath for it, but from which it can be entirely separated by careful dissection. I have mostly found it constitute a single sac, but quite independent of the neighbouring tissues.

M. Velpeau, on the contrary, seems to consider it more as an accidental formation; "over the olecranon the cellular tissue is condensed in such a manner that it often gives rise *to a real bursa mucosa, of variable capacity, and contains but little fluid* in its healthy state, but is easily filled upon the slightest injury[1]." M. A. Berard[2] says, he has seen this bursa contain several cavities; from repeated dissections, I am induced to believe that this bursa always exists in the natural or healthy state of the limb. Beclard[3], who perhaps took undue credit to himself as regards the description of the bursæ mucosæ, remarks that this sac is found before birth, and can easily be seen on account of a sufficient quantity of fluid which lubricates its interior." This bursa, like that of the patella, is sometimes distended with fluid of various natures, which has been described under the name of hygroma. Some surgeons have proposed injecting this cavity with stimulating fluids, as in hydrocele: when this operation is performed, great care must be taken to avoid injecting the cellular tissue around the bursa, which would cause considerable inflammation. This bursa is constantly exposed to blows, yet it is but seldom found diseased. In fractures of the olecranon it must generally be more or less injured, on account of its being so intimately attached to that bone.

The principal muscles worthy the surgeon's attention in this posterior region are the following:—The triceps muscle, which at its lower end is provided with a strong tendinous-like fascia, fills up the hollow surface situate between the two condyles of the humerus; and, when the limb is extended, almost prevents the olecranon from projecting, owing to its thickness rising nearly to its level; when the fore-arm is bent, it is this muscle which forms the flat surface of the elbow immediately above the olecranon. The greater part of the outside of this muscle is formed by a broad tendinous-like fascia which is very similar to that of the rectus of the thigh. This broad tendon sends off an aponeurotic fascia which inserts itself along the external and posterior edge of the ulna, covers the anconeus muscle (which partly arises from it), and also inserts itself into the external condyle of the humerus, and unites to the tendinous origins of the muscles which spring from that eminence. This fascia does not spread over the back part of the ulna, which is merely covered by its periosteum, bursa mucosa, and cellulo-fibrous tissue. The thickest part of the triceps muscle is found exactly in its middle, and is inserted into the olecranon. The outer fibres of this muscle are inserted into the back and upper part of the external side of the cubitus along side of the anconeus muscle; the tendon of the triceps does not extend so far inwardly as it does on the opposite side: there is generally a fleshy portion of this muscle lying close to the cubital nerve.

M. Velpeau, who justly remarks that the tendon of the triceps is not inserted into the most prominent part of the olecranon, but rather towards the articulating surface of the joint, says, that this disposition favours the formation of a synovial membrane which he has sometimes discovered. I have never yet met with this occurrence. The front of this muscle, which lies immediately upon the capsular ligament of the elbow-joint, to which it is likewise connected by means of a number of cellular fibres, may probably draw up the ligament during its contraction. This powerful muscle extends the fore-arm, and is likewise a "tensor of the aponeurosis which binds down the anconeus muscle and prevents its being seen during its contraction.

The anconeus muscle which some anatomists consider merely as a portion of the triceps muscle, on account of its course, use, insertion, and the frequent difficulty of separating the one from the other, is of a triangular shape, flat, and fills up the hollow surface on the outside of the olecranon, and the space between that process and the head of the radius. Its superior fibres arise fleshy from the upper part of the outer condyle of the humerus, and are generally united to the triceps muscle; the middle and lower fibres spring by a small round and strong tendon from the lower and back part of the outer condyle of the humerus; this tendon passes along the side of the head of the radius, and must contribute to prevent luxations of that bone outwards, an accident of rare occurrence, but which has come within the vast experience of Sir A. Cooper.

At the inner and back part of this region, between the tuberosity of the condyle and olecranon process, is a furrow through which the ulnar nerve passes; the exact course of this nerve is highly important to the surgeon; it is seen first passing along the inner side of the front of the arm, on the inside of the basilic vein, and lying upon the triceps and brachialis muscles; it finally proceeds obliquely towards the back surface of the inner condyle, in which is a smooth groove to receive it; some fine cellular tissue merely separates the nerve from the bone, which, on account of the smoothness of the passage requires no additional protection; it is a law that no nerves possess synovial membranes, these organs being reserved for parts exposed to much displacement and pressure; the ulnar nerve is surrounded by a small quantity of adipose substance. This nerve being near the integuments, and placed upon a bony and resisting surface, is easily compressed, which produces a sensation too well known to merit notice. Sometimes, however, this nerve is not uncovered by muscular fibres. In my recent dissections, I have twice met with a small transverse muscle, about one inch in breadth, extending from the olecranon to the tuberosity of the inner condyle; these muscles are perfectly independent of the triceps and flexor carpi ulnaris muscles. I am not prepared to say how often they may exist, nor what may be their use, unless to protect the ulnar nerve, and to raise up the capsular ligament and synovial membrane. The surgeon, however, might be a little surprised, if, in cutting down upon this nerve (with a view of following Scarpa's example of dividing it, for the cure of neuralgia ; see his Opusculi di Chirurgia, p. 38), a transverse muscle should present itself ; for this reason we have mentioned its existence ; for, what in nature's sports occurs twice, may occur again. The ulnar nerve is easily separated from the cellular tissue, and made to slip over the tuberosity of the condyle, a precaution which ought always to be attended to in excision of the elbow-joint; for this nerve might otherwise be injured: and several such instances have taken place.

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[1] Page 247. Loc. cit. vol. ii.

[2] Dict. de Médecine, t. ix. p. 221.

[3] Anatomie Générale, p. 188.

The outer or radial projection which extends from the front to the back of this region, is composed of the supinator and radial muscles. It is generally described as being formed principally by the supinator radii longus muscle, but this is not exact. The supinator longus muscle presents two distinct shapes ; above the bend of the elbow its superior extremity is flattened sideways, and fills up the space on the outer side of the arm which exists between the triceps, biceps, and brachial muscles ; but when the supinator longus reaches the situation of the head of the radius, it becomes flattened in the opposite direction, from before backwards, taking thus the shape of the subjacent extensor radialis longior muscle, upon the anterior side of which it lies ; and cannot for this reason, form alone, the radial eminence, as many writers assert. The extensor radialis longior has rather a thick belly ; it lies immediately upon part of the supinator radii brevis ; it covers the radial nerve ; it is in contact with the front side of the outer condyle of the humerus, and with the outer border of the brachialis anticus muscle. It is this muscle principally which contributes to form the radial projection. In this situation we find the radial nerve, which first lies on the outer side of the brachialis anticus muscle, and covered by the supinator radii longus; lower down, this nerve is bounded on its inner side by the tendon of the biceps muscle, which separates it from the brachial artery and veins, and from the median nerve. The recurrens radialis artery and veins lie on its inner side. This nerve passes over the supinator radii brevis, where it gives off several branches which supply the neighbouring muscles ; and lastly, divides into two principal branches, one of which dives under the supinator radii brevis muscle. The radial nerve is generally surrounded by a good deal of adipose substance ; nevertheless, it will be easily understood, that in dislocations of the head of the radius, this nerve must experience more or less compression, and hence the pain in the thumb and fore-finger can be accounted for. The other muscles, which insert themselves into the outer condyle and contribute to the formation of this region, as well as to the strength of the radial articulation, by their fibres being intimately connected with its ligaments, are the extensor digitorum communis, the extensor carpi ulnaris, and the anconeus muscle. This last muscle has sometimes been considered merely as a part of the triceps muscle, on account of the origin, direction, and insertion of their fibres being nearly similar ; nevertheless, this small muscle is attached chiefly along the outer edge of the ulna from its middle to the top of the olecranon, where it is intimately connected to the triceps fibres ; it arises by a small round but strong tendon from the external condyle of the humerus, and passes over the side of the head of the radius ; this tendon gives considerable strength to the articulation. M. Malgaigne has fallen into a singular mistake with regard to this muscle, which he describes as lying on the inside of the olecranon, and as covering the ulnar nerve. The error here is not simply typographical, as it consists in placing the muscle on the wrong side of the articulation.

The arteries surrounding the articulation have been already noticed in the operations for aneurism ; it will be, therefore, unnecessary to dwell on them in this place. It sometimes happens in wounds of this region that one of these small arteries is divided, and may be productive of serious bleeding ; attempts have been made to arrest the hæmorrhage by enlarging the wound, and securing the mouth of the bleeding vessel; an operation which has sometimes succeeded. Sometimes, however, it is quite impossible to secure the artery; hence many surgeons prefer tying the brachial artery in the arm. In such a proceeding, where should the ligature be placed? This must depend upon the vessel which is wounded. Suppose, for instance, it were probably the external collateral branch, just above the outer condyle of the humerus ; here it would be prudent to tie the brachial artery high up before it gives off this collateral branch ; if, on the contrary, the bleeding were caused by the injury of the ramus anastomoticus, or recurrent branches, tying the artery about two inches above the inner tuberosity of the condyle of the humerus would be sufficient; it is perhaps for not attending to these anatomical reasons, that such hæmorrhages have not been arrested by the ligature of the brachial artery.

(C. Tarral.)

ARMAMENTARIUM, *arsenal*, Fr., adopted by old surgical writers to denote a general magazine of instruments and surgical apparatus, and hence taken by Scultetus and others as the title of their works treating of all that relates to this province of surgery.

ARSENIC, *arsenicum*, Lat. ; ἀρσενικὸν, Gr. ; *Arsenik*, Ger. Arsenic of commerce is the arsenious acid of the chemist. It exists native, and is procured abundantly during the extraction of other metals from their ores, more particularly cobalt. This ore is thrown into a furnace to which a flue or horizontal chimney is attached, through which, during an exposure to heat, the fumes pass, and are condensed into a greyish or blackish powder. It is afterwards purified and consolidated by sublimation in large iron mattrasses. It is then brought into the drug market under the appellation of white arsenic, in large colourless inodorous masses, which are generally opaque; when recently broken their internal structure presents a vitreous appearance. It is volatilized at the temperature of 383° F., and emits a smell somewhat resembling that of garlic; but when carefully heated, far from the contact of any substance that can decompose it, this alliaceous smell, which has been by some regarded as a test, is not perceptible. Its specific gravity is 3·7. Its taste is strikingly nauseous; it creates a singularly astringent sensation about the mouth and fauces, and excites a flow of saliva and a painful sense of constriction. It has been called arsenious acid very properly, for it unites with potash, ammonia, and soda, forming soluble compounds; one of these, the arsenite of potash, is introduced into our pharmacopœias under the name of liquor potassæ arsenitis, or Fowler's mineral solution. This has gained great reputation in the cure of diseases of an intermittent type. The French Directory, during the march of the French army through the marshy plains of Lombardy, issued a decree commanding the surgeons, under pain of military punishment, to employ a similar preparation of this mineral for the soldiers who were suffering from intermittent fever, produced by malaria. Arsenic has long been employed in the treatment of cancer, and has at different times been highly extolled, and at others as much depreciated; it has formed the basis of almost all the quack remedies which have claimed any reputation in the cure of the disease, and various articles have been employed to disguise it from the patient. Fuchsius united it with soot and serpentary, and Richard Guy, with sulphur, hog's fennel, and soot. Its topical employment is chiefly indicated in cases of cutaneous cancer; and it should be steadily repeated till every trace of the disease be removed. In proportion to the degree of inflammation excited is the chance of its absorption diminished, and the risk of deleterious consequences precluded. Messrs. Sachs and Dulk assert, that its erosive power is greater than that of any other known remedial agent, with the exception of fire; and that of all potential cauteries, it most efficiently obviates the absorption of the morbid virus. They also mention their having known numerous instances of a perfect and lasting cure having been wrought by its means in cancers of the skin. Failure was to be attributed to its untimely application[1]. It is only as a caustic that arsenic acts beneficially in such cases; since there is no good evidence of its internal administration having proved serviceable.

Mr. Carmichael has promulgated some peculiar notions on this head, in his work on Cancer, to which we must refer our reader. It must always be remembered, that the utmost danger from absorption of the poison into the system attends the external application, and that the powder sprinkled upon the sore often produces intense pain, without exciting any other remarkable symptom, whilst, again, on other occasions violent inflammation and local irritation have suddenly supervened. Roux narrates the case of a young girl aged eighteen, who died in consequence of the application of the *pâte arsenicale* to a cancerous breast: it has been found, from experiment, that inflammation is produced in the stomach of the dog, not only more violently, but more rapidly by the application of arsenic to a wound, than where it was given internally, every precaution having been previously taken that no delusion should arise from the animal being suffered to lick the denuded surface.

In hospital gangrene, the solution of arsenic is found most valuable. Mr. Blackadder, during the Peninsular war, employed it at Passages with the happiest effect, and Hennen, in his Principles of Military Surgery, gives a long description of the plan that was followed:—The first step is to make the sore perfectly clean, and freed from the viscous discharge; but as this cannot be easily effected by common means, without occasioning a disagreeable oozing of blood or a considerable degree of pain, the ablution is made from two large hospital teapots, one containing a hot solution of the subcarbonate of soda, the other a cold one, that the one or the other may be employed as the feelings of the patient for the moment dictate; the glutinous matter which adheres to the sore may be gently detached by means of small dossils of lint: sponges are to be avoided, in consequence of the expense, for the dread of contagion must prevent their being employed more than once: dry lint may be spread on the surface of the sore, as soon as it is perfectly clean, and removed, and fresh lint applied until the sore is perfectly dry. The solution of arsenite of potash, diluted with an equal part of water, is then applied through the means of pieces of lint, which are to be well soaked, and renewed every fifteen minutes or half an hour; sometimes on the first application it is necessary, particularly in irritable or debilitated constitutions, to administer an opiate, and to repeat it according to circumstances. The use of the solution is to be continued until an insensible dark-coloured and dry slough occupies the whole surface of the sore, and until the patient is completely relieved from the burning and lancinating pain, which is in some degree characteristic of the disease. These cases require great personal attention on the part of the surgeon, as the application of the remedy in this form cannot be entrusted to the patient or his usual attendants, and every step of the manipulation demands great precaution, more particularly if the fingers of the surgeon be accidentally abraded.

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[1] Handwörterbuch der Praktischen Arzneimittellehre, Part I. p. 475.

The uncertainty of the effect of arsenic applied to ulcers has been assigned to different causes. Mr. Blackadder, who states that he never saw more than one instance of its deleterious operation, although he had for a length of time employed it, attributes his success to his having always applied very large quantities, which he believes very quickly destroy the organization, and necessarily prevent the action of absorption. Harles remarks that it is perfectly innoxious when applied to an abraded surface, to sores, or to malignant ulcers, even in a high state of irritation, provided the part be not recently wounded, and that no blood issue from it; for it is by the direct application to the open vessel that it is absorbed, and that with the same certainty and rapidity as if it had been injected into the vein. The powder of Frère Côme, Plunket's powder, the pommade of Hellmund, are the compositions applied to the ulcers of the face and nose, which occasionally commit such ravages; these preparations generally produce eschars, and considerable pain and tumefaction. Dupuytren has therefore given some formulæ, which possess a different mode of action, and modify the effects. For this purpose he employs calomel; he recommends a powder formed by mixing one part of arsenious acid with ninety-nine parts of calomel, sometimes increasing the proportion of the arsenic to five or six parts. His liquid preparation consists in the simple solution of arsenious acid and calomel in distilled water, or in the form of a paste with gum, generally making the solution a little stronger than the powder. The *pâte arsenicale* has one part of the arsenic to thirty-two of fatty matter. The powder of Rousselot consists of one part of arsenic, sixteen parts of the red oxide of mercury, and eight parts of the resin of Pterocarpus Draco, which has been said by Cullerier to prevent the absorption of the poison.

During the internal administration or external application of arsenic, great attention must be paid to the state of the digestive organs, for should a gastro-enteritic state supervene, other bad symptoms soon follow, and blotches on the skin rapidly becoming gangrenous, or paralysis of the lower limbs, quickly evince the poisonous effect. This drug should not be combined with any acid. The dose, at first, should be very small; the sixteenth of a grain twice or thrice a day is quite sufficient to commence with, for three quarters of a grain have produced sensations of constriction at the throat, spasms, diarrhœa, or vomiting: very little more should be left in possession of the patient than may be required. It is best to exhibit it immediately after a meal, when the stomach contains food. Should any bad effects follow, opium may be exhibited; and, if inflammatory symptoms supervene, blood-letting, both general and local, ought to be employed. Orfila has recommended sulphuretted hydrogen condensed in water as a direct means of counteracting its virulence. More recently, hydrated sesquioxide of iron has been proposed as a chemical antidote by MM. Berthold and Bunsen; and several cases have been recorded of its efficacy. But little reliance can be placed on lime-water or magnesia, although they are most generally recommended. In the copper-mines of Cornwall, sweet-oil is employed as a preventive to the bad influence of the arsenical vapours. The effluvia from arsenic is said to be destructive to those who for any length of time are exposed to it; both animals and vegetables are materially affected in the neighbourhood of copper-mines, but it is stated that in aguish countries, it is a preventive to the development of intermittent fever. During the plague at Marseilles, arsenical fumigations were tried, but Chirac pointed out their deleterious agency.

(*George G. Sigmond.*)

ARTERY, ARTERIES, *'Αρτηρία*, Gr.; *Arteria*, Lat.; *Artère*, Fr.; *Pulsader, Schlagader*, Ger. The arteries are the canals or tubes which serve for the transmission of the blood from the ventricles of the heart. They arise from it by two trunks—that from the right ventricle, called the pulmonary artery, supplies the lungs—that from the left, (the aorta) all the other parts of the body. From these two sources, they ramify into numberless subdivisions in an arborescent form. Considered as to structure, they possess three distinct coats; the external, or *cellular*, derived from the parts through which the vessel passes, and on which its power of resistance mainly depends; the *middle*, or *fibro-elastic* coat, consisting of transverse or circular fibres, of a yellowish hue, and strong in proportion to their proximity to the heart. This has been also called the *muscular coat;* and the *internal*, or *serous* coat, which forms the lining of these vessels. The two latter coats are much more fragile than the first, and between them the *vasa vasorum* may be traced.

The characters of each of these coats are perfectly distinct. The cellular tunic is thick, filamentous, and compact. The middle tunic is firm, dry, and elastic, its fibres being arranged in concentric layers, having a slightly oblique, or spiral direction. It is to the firmness of this tissue that the cylindroid form of arteries is chiefly owing, while its elastic properties confer a power of accommodation to the varying volume of blood transmitted through these vessels. This tunic is found in all arteries, even in those of the brain, and is only rendered indistinct from the diminished size of the vessels. The internal tunic is smooth, polished, moist, and when separated, transparent; it is also firmer and thicker in the arteries than in the veins and lymphatics; and contributes chiefly to form the various valves of the vascular system. Some anatomists con-tend for the existence of a cellulo-nervous coat between the internal and middle tunics, relying for the proof of the fact on the frequent development of calcareous or other formations in this situation, as well as on their power of demonstrating its presence between the lining membrane and the muscular substance of the heart.

The colour of the large arteries is a whitish yellow; that of those of middle size, reddish; while in the very small arteries, it is nearly red. They are plentifully supplied with minute blood-vessels, the *vasa vasorum*, and with nerves, chiefly from the ganglionic system, which may be distinctly traced twining round the large vessels, especially in the cavities of the thorax and abdomen.

The question whether arteries possess contractility independent of the heart, though denied by many very eminent physiologists, is now resolved in the affirmative. The action of these vessels is a compound, of contractility derived from the fibrous or proper tunic, and of retractility from the cellular coat; all their tissues are extensible, though in different degrees. In consequence of these powers in the coats of arteries, the progression of the blood through them is promoted; their pulsations however are isochronous with the contractions of the ventricles, and are chiefly dependent upon them.

The doctrine which referred all the various morbid alterations of arteries to chronic inflammation of their tissues is now no longer admitted. The degenerescence of these vessels, like that of other tissues of the body, results from causes obscure in their action, it is true, or altogether unknown, but nevertheless partaking by no means of the nature of inflammation, but seeming rather to depend, at least in the case of the arteries, on that slow and gradual modification of nutrition which seems to keep pace with the advancement of age.

Arteritis, or *Inflammation of Arteries*[1].—The study of the intimate tissues of our organs has accomplished the same results for the pathology of the arteries, as it has for any of the other organs of the economy; that is, it has enabled us to recognize the different susceptibilities of the several arterial tissues, and their liability to be affected separately, successively, or conjointly. But we do not mean to say that the light shed on the affections of the arteries is equally great, as in the instances of other organs, for, on the contrary, notwithstanding the attention that has of late years been bestowed on the pathology and surgery of the arterial system, perhaps but little progress has been made, as regards the idiopathic alterations of condition, that occur in this order of vessels. The structures that enter into the composition of an artery, seem not to be very susceptible of inflammation, but of course in this respect there must be some variety; the tissue that appears to be endowed with the greatest power of resistance to it, is the middle fibrous, or elastic coat, whilst that which resists it the least is the internal membrane with its subjacent cellular tissue. But, so far from easily assuming the inflammatory process idiopathically, arteries are often seen traversing the cavities of tubercular abscesses, exposed in extensive, and even phagedenic ulcerations, without participating in the disease; and when they happen to give way and burst, it is from being extensively denuded of their cellular coats, and thus deprived of nutriment. An artery examined under such circumstances, shows no increase of vascularity, nor any of those appearances that are said to depend on inflammation. On the other hand, the internal coat, which many regard as analogous to serous membrane, is often found red and vascular, with deposits of various kinds, either on its surface or between it and the fibrous tunic.

From their general insusceptibility of disease, therefore, it may not be unfair to assume, that idiopathic arteritis is of rather rare occurrence, and even when present, it is doubtful whether it be accompanied by symptoms sufficiently clear to establish a satisfactory diagnosis. True, when it has produced its lamentable and too often incurable effects in the development of aneurism, it may then be presumed to have been in existence at an earlier period; but now the appearances of inflammation have passed away, and an autopsy may show alterations of structure, of shape, or of dimensions in the vessel, but nothing explanatory of the first and early deviations from its state of health.

There is another circumstance which adds to the difficulty of these investigations. Arteries, particularly the large ones, are often found deeply dyed internally; and this appearance has been generally, and I believe properly, attributed to transudation. By the experiments of Rigot and Trousseau, moreover, it has been shown that in some instances the aorta, when slit down its entire length, although on its first being exposed to the air, it presented its ordinary pale colour, soon assumed a deep crimson hue, without having been in contact with the blood; and, again, when immersed into water, the natural pale straw-colour of the aorta was restored. Such being the fact, how can a difference be discovered between the two cases, one the vascularity of inflammation, the other, the mere physical result of transudation, more especially when, as it has been already observed, the history of the case throws no *certain or positive* light on the dissection. The depth of colour will afford no assistance, as it may depend on the length of time that has elapsed since death, and a number of other causes. There is nothing like distinct vascularity in an inflamed artery; nothing like separate, injected, and distended vessels, as in an inflamed conjunctiva; the redness is broad and patchy, and may be removed by immersion in water, or by washing, as perfectly and perhaps as quickly, as that produced by transudation. Under such circumstances, I should hesitate to pronounce any appearance of redness on the internal surface of an artery, as indicative of inflammation, unless it were accompanied by other phenomena generally taken as the results or effects of this process on the arterial structure, such as thickening, friability, and softening, and some of which, it is probable, are developed with great rapidity, and at an early period. At the present day therefore, there are but few if any pathologists who are disposed to interpret the simple red coloration of the lining tunics of arteries as conclusive evidence of inflammation; or to maintain with Franck, that it is pathognomonic of inflammatory fevers.

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[1] This subdivision of the article, down to the bottom of p. 382, has been furnished by my friend Mr. Porter of the Meath Hospital, Dublin.

Causes :—As external causes are known to to have but little influence in exciting inflammation in the arteries, in which respect their difference from the veins is very remarkable, it is assumed that the abuse of spirituous liquors, mercury, &c. may lead to its development.

But whether it is thus produced, or not, the symptoms to which it gives rise vary exceedingly in intensity: they may be as obscure as when a ligature is applied on a vessel, producing neither local inconvenience, nor reaction of any kind; or the fever may run high, with severe pain in the course of the affected vessel. When this is the case the danger to the limb, and even to life itself may be very great. The artery is exceedingly painful, and like a chord to the touch; the pulsations may still continue, or be almost wholly obscured; the limb swells, becomes covered with phlyctenes, and falls into gangrene, or, as has been observed by MM. Graves and Stokes, is for a time partially paralysed.

This variety in the degree of intensity of the inflammation, is not alone referable to its occurrence in different individuals; for even in the same individual, one inflamed portion of an artery shall have poured out coagulating lymph, and be in full progress to obliteration, whilst another shall not exhibit a single particle of lymph, or indicate the slightest tendency to this process. But I shall not dwell on this point now, as an opportunity will be afforded for discussing it in another place; for the present, it will be sufficient to remark that as these effects evidently tend different ways, one towards the safety of the individual, and the other, too often, to his destruction, it may not be altogether improper to designate these forms of inflammation by the terms, *healthy* and *unhealthy*. The healthy is very generally the result of accident, or injury: the unhealthy, as may be anticipated, is more frequently idiopathic.

The supposed consequences of arteritis may be arranged into two classes, one, as they occasion alterations in the structure and functions of the vessel itself: the other, as inducing disease in different and distant parts. According to Cruveilhier, the essential character of commencing arteritis is the coagulation of the blood within it. This is observed in the healthy or adhesive inflammation occasioned by a division of, or the application of a ligature on, a vessel, when a coagulum is found to occupy the interspace between the ligature and the next collateral branch: but is still more remarkable in the unhealthy or spontaneous, where it is the most frequent cause of the gangrene that occurs in old persons[1]. That coagulated blood is generally found after death within an inflamed artery is well established by dissection, but that this is the result of the inflammation is more than questionable. In a case that occurred in the Meath hospital[2], and which was accompanied by the senile gangrene of the toes and feet; the femoral artery, which was greatly enlarged, was found after death filled with a coagulum, but during life the blood unquestionably circulated through it, the motion imparting to the finger the sensation of a weak and indistinct thrill like that felt on touching the course of the urethra whilst the urine is passing. In another case treated in the same institution, where a ligature had been placed on the femoral artery, the segment below the cord exhibited the deepness of colour and the increased calibre of an inflamed vessel, but contained not a single particle of coagulum of any description, although there was no collateral branch within a considerable distance. Under these circumstances, and seeing that the aorta, at its arch or even before the arch is formed[3], is often the seat of inflammation, in which case the whole circulation should be stopped, it may be doubted whether the formation of a coagulum is an effect of inflammation during life; that which is found after the application of a ligature being the result of the stagnation of a small quantity of blood between it and the next collateral branch.

The early effects of healthy arteritis on the vessel itself, are scarcely appreciable by our senses, except in experimenting on animals, a mode of investigation, that will be found very inadequate to explain the effects of disease in the human subject. In Jones's experiments I do not find any mention made of the condition of the vessel with respect to an increase of vascularity, and in some trials of my own I could not say, whether the redness observed, was the result of transudation or not. In man, it is not easy to obtain an opportunity for satisfying ourselves on this point, but judging from analogy, it may not be unfair to assume, that arteritis is ushered in by an increase of vascularity and of redness, followed, however, very speedily by an effusion of organizable coagulating lymph on the surface of the internal membrane; which, if the surfaces are laid together, will in a short space so glue and fasten them, as to close the vessel at that point. So far, then, a healthy inflammation of an artery *terminates* by a species of union by the first intention, and whatever other results have been attributed to this cause, they may probably be more easily explained by referring them to a different source. It has been supposed by high authority, that the obliteration of large tracts of arteries, such as of the umbilical arteries, and the ductus arteriosus in the infant, and of the interspace between a ligature and the next collateral branch in any subject, is the result of a certain species of healthy inflammation; but these phenomena are so unlike the effects of an inflammatory process as generally observed, that it is difficult to ascribe their occurrence to this cause. What evidence is there of the existence of inflammation in the umbilical artery of the infant, and if it did take place, would the result be the obliteration of the vessel[1]? What is there in the casual existence of a collateral branch to check the sporadic tendency of inflammation, and limit its extent within a given space, perhaps within the one-eighth of an inch or less? It may, after all, be only quibbling about a name, but I would rather attribute this phenomenon to a general law in the animal economy, which tends to the closure of all canals when no longer permeated by the substances for which they were designed to afford a passage: a law, the operation of which is seen in the closure and obliteration of veins as well as arteries; in the diminution of the calibre of the lower portion of the bowel where an artificial anus exists; in the contraction of the urethra in fistula in perineo; and in many other cases, which it is now unnecessary to specify. It will be seen hereafter, that the tendency of arteritis is rather to increase than to diminish the size and capacity of the affected vessel.

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[1] Dictionnaire de Médecine et de Chirurgie Pratiques; tom. iii. pp. 394, 395. Article, Maladies des Artères.

[2] The phenomena and results of this case attracted considerable attention amongst the medical attendants and were particularly remarked by my friend and colleague Dr. William Stokes. The preparation is in the museum of the Park st. school.

[3] See Dublin Journal of Medical Science.

The very early symptoms of the unhealthy inflammation of arteries are not known. In some instances, acute and severe pains have been experienced before the appearance of internal aneurisms, but in others there has been even more satisfactory evidence of the existence of the disease without the patient's complaining of any suffering: I can therefore only avail myself of examples in which the disease was fully formed, in order to describe its appearances and effects. When an opportunity is afforded of examining a vessel in this condition, and its coats are slit up longitudinally, the internal membrane appears to be of a bright crimson or carmine colour, varied with small spangle-like patches of a paler and more opaque tint. This vascularity is not confined to the lining membrane, for on removing this, the fibrous coat is seen also to be deeply stained. Between these, but more closely attached to the former (for it is removable with it,) is a deposition of a soft cheesy steatomatous material, which being seen through the lining membrane, gives it that patchy appearance already mentioned. An artery in this condition is remarkably increased in calibre[1]; its properties, both of contractility and elasticity are diminished, and it easily breaks down and tears, under an extending force that would have little or no effect on a vessel not the seat of disease. Probably in a very short time after the formation of this steatomatous deposit, ulceration commences in the lining membrane, which, proceeding from within, erodes the middle tunic to a greater or less extent of depth, and thus leads to the production of aneurism.

The symptoms that indicate the presence of arteritis, have not been clearly laid down, and moreover are such as might easily be overlooked, if not sought for by a careful and even rigid examination. It has been already stated that the previous occurrence of pain is not a satisfactory diagnostic. In the case of inflammation of the femoral artery already alluded to, Dupuytren stated, that a dull heavy pain had been previously felt in the iliac fossa of the same side, from whence it descended along the internal part of the thigh, then to the posterior part of the leg, and finally reached the sole of the foot and the toes. He also speaks of the patient having been annoyed by cramps, and in general, persons suffering from aneurism of the aorta accompanied by inflammation complain of pain in the back, stitches in the side, and spasms in different parts of the chest. Where gangrene is threatened, the temperature of the limb is diminished below the situation of the inflamed artery, and the coldness is felt to be increased in intensity as the examiner proceeds downwards, the sensibility being impaired exactly in the same proportion. On laying the finger over the course of the vessel, its pulsations are found to be weak, tremulous, and indistinct, the artery in its entire course appearing to be converted into a hard incompressible cord[2].

As a consequence of arteritis, suppuration within the vessel must be of rare occurrence; nevertheless it may be met with, either occupying the whole calibre of the artery for a given space, as in the case already quoted from Cruveilhier, or more generally in the centre of, or intimately mixed up with clots of fibrine or coagulable lymph. In no case, that I am aware of, has purulent matter been found mixed with the blood in the arterial circulation: neither do I know of a single instance of gangrene of the vessel itself supervening as a consequence of idiopathic inflammation.

The treatment of arteritis has not been distinctly explained, farther than that it should be antiphlogistic in the fullest acceptation of the term. When it is acute and of a healthy character, tending to adhesion and obliteration of the vessel, it should not be interfered with: Nature is about to perfect a salutary process, and ought not to be disturbed in her operations. Nothing is requisite in such a case but absolute rest; and when there is an accompanying wound, the surgeon should be careful in paying the requisite attention to it, not to permit any unprofitable meddling with the vessel. But in the unhealthy form of arteritis, and more particularly where it is idiopathic, I question very much whether the general and sweeping direction to treat it antiphlogistically, is either rational or scientific. Whether correctly or not, I have been accustomed to regard this inflammation as bearing a strong analogy with erisypelas, particularly in its sporadic tendency, in the kind of fever that often accompanies it, and in the class of persons it attacks. It ought to be borne in mind also, that inflammation of an arterial trunk in an extremity (the only situation in which it can be recognised,) is frequently followed by gangrene of the limb below it, and this is a process not likely to be arrested in its progress, or benefited in its treatment, by active antiphlogistic measures. I suppose, therefore, that arteritis is to be submitted to a course of management having relation to the age, constitution, and habits of the patient, the probable exciting cause of the malady, and the circumstances in which he may be placed with respect to air, diet, clothing, and those other numerous conditions, which, however superficially regarded, are constantly found to influence disease in all its forms. In some cases, perhaps, a rigid and general antiphlogistic treatment may be necessary; in others it may be more modified and more locally directed; and in others still it may be easily conceived that camphor, musk, ammonia, and wine might prove the most suitable and successful medicines. In any line of treatment, however, our present stock of knowledge is not sufficient to enable us to predict a favourable issue to any given case. The disease usually is completely formed before it is discovered, and when discovered, it is in consequence of the occurrence of aneurism, mortification of the extremities, or some other result, the importance of which throws the original exciting cause entirely into the back ground. The consecutive disease either occupies the surgeon's undivided attention, or if not, and he discovers the existence of the arteritis, he finds his interference has come too late, As far as I know, the records of surgery offer nothing cheering or encouraging in the management of this afflicting malady; but this, instead of diminishing our confidence in the resources of the art, should rather stimulate us to further exertion, in order to render them available. For this purpose the etiology of the disease should be carefully studied, and the early symptoms so described and arranged, that they may be easily discovered at the only period at which medical aid can be advantageously resorted to; namely, at the commencement.

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[1] "I have seen the body of an infant some days old, in which, the umbilical artery, *greatly dilated*, was filled with pus to the extent of nearly two inches." Cruveilhier, loc. citat.

[1] Dupuytren has related a case, in which the artery was found in the opposite condition. "A la partie moyenne de la cuisse l'artère, quoique d'apparence normale, était rétrécie, occupée par un caillot presque filiforme, rosé, et qui parut s'être formé après la mort. Leçons Orales; tom. iv. p. 489.

[2] This does not exactly correspond with my own experience, for I have felt the artery of the thigh during life, and satisfied myself that it was greatly enlarged; a diagnosis that was verified afterwards by dissection.

Having paid a considerable degree of attention to the pathology of aneurism and other organic lesions frequently met with in connexion with that disease, and having satisfied myself that arteritis was one of its immediately exciting causes, I have latterly investigated the history of every case that presented itself, and have come to the conclusion that intemperance, particularly in the use of ardent spirits, and repeated or ill-conducted courses of mercury, were most generally and most intimately connected with the production of arterial inflammation[1]. This latter medicine is seldom used in great quantities, or for any protracted length of time, unless for the cure of syphilis, and hence many have entertained an opinion that arteritis might be a result of the operation of the venereal poison. In this supposition, I find Scarpa, Richerand, Corvissart, and to a certain extent Mr. Hodgson, seem to coincide[2]. Dupuytren, in examining arteritis in connexion with gangrene of the extremities, states that it is found almost always in persons that have indulged too freely in spirituous liquors, in stimulating food, and in those who have suffered from chronic diseases of the heart, or of the aortic valves or great vessels[3]. Bouillaud, amongst the other causes that may produce inflammation generally, enumerates fatiguing and continued exercise, stimulating drinks taken in too great quantity, and the abuse of spirituous liquors as particularly conducing to arteritis[4].

However occasioned, it tends to the one invariable result, the creation of a dilated or aneurismal condition of the vessel itself, and hence it may be regarded as a pathological condition to which the arteries of persons in very early life are not subject. It has recently been adduced by Cruveilhier, Dupuytren, and others, as the immediately exciting cause of a particular form of gangrene, which attacks the extremities, and which, according to these pathologists, is produced by the stagnation of the blood within the inflamed vessel. I have seen some cases of mortification of the extremities in connexion with arteritis of the leading trunk of the limb, and I have used the term, "particular form of gangrene" here, because I believe it to be by no means identical with the affection known in this country as Pott's mortification of the toes and feet. It is much more rapid in its progress, and consequently, more extensively destructive; it often destroys the integuments of the part engaged, a long time before the deeper structures are attacked; it is infinitely less painful, but, at the same time, I believe it is infinitely more dangerous. This, however, is not the proper place for the discussion of this part of the subject, and the reader must be referred to the articles GANGRENE, MORTIFICATION, &c. &c.

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[1] Cyclopædia of Anatomy and Physiology; article, Pathological Conditions of Artery.

[2] Hodgson on the Diseases of Arteries and Veins, p. 9, 10.

[3] Leçons Orales, tom. iv. p. 483.

[4] Dict. de Méd. et Chir. Pratiques, tom. iii. p. 413.

The little tendency evinced by arteries to be affected by the morbid changes which may be going on in the tissues or organs through which they pass, has been already alluded to in the commencement of this article. It does not, however, amount to an entire exemption in their favour from attacks of this nature; and hence we find their coats soft, and extremely friable where they traverse cancerous tumours or other diseased structures. In such cases, their cohesiveness is greatly diminished, so that they break under the fingers, or they feel soft and sometimes spongy. There are even instances on record, in which erosion, propagated from a neighbouring bubo, has attacked the artery, giving rise to fatal hæmorrhage. Mr. Hodgson mentions a case of fatal hæmatemesis, where the coronary artery of the stomach had been eroded from an ulcer of the mucous membrane of that viscus; and the same thing has been observed to occur in the lungs.

Aortitis.—In connexion with the preceding observations, for most of which I am indebted to Mr. Porter of Dublin, who has so successfully cultivated this department of pathology, it will be proper here to refer to the recent researches of M. Bizot of Geneva, on this interesting subject. These researches, conceived on an extensive scale, have been conducted with remarkable ability and zeal, and are recorded in the first volume of the *Mémoires de la Société Médicale d'Observation.* M. Bizot had observed but one form of alteration resulting from an acute attack of the internal lining of arteries. It showed itself upon the surface of this membrane in the form of an albuminous exudation, varying in thickness, as well as in consistence, and resembling jelly, being smooth, transparent, limpid, or rose-coloured. In some instances, the transparency of the adventitious membrane was such as to allow the pale colour of the artery to be distinguished beneath it. If a portion of the lining membrane be raised and torn off in the direction of the new deposit, the latter, behind which it is placed, and from which it may be separated, tears off with it. These exudations were in general confined to one spot, but they were also observed in scattered groups or patches of various sizes, and in some cases the transparent matter was so abundant as so fill up completely the calibre of the vessel. It is very frequently found at the orifice of the arteries arising from the arch of the aorta, of the cœliac, mesenteric, and renal arteries, and on the posterior surface of the aorta, obliterating partially or completely the orifices of the intercostals. Sometimes the albuminous spots appear puckered round their edges, which made Mr. Hodgson liken them to atrophied hernial sacs. When this matter exists in the form of isolated patches, it probably does not give rise to any general symptoms; but the case is just the reverse, when the morbid secretion is thrown out extensively on the internal surface of the large arteries. M. Bizot thinks that acute aortitis occurs in this way, and cites three examples observed by himself; the disease, in each case, terminating fatally. The symptoms observed were œdema accompanied by fever, but without any disturbance in the functions of the heart, or of the other organs essential to life; and these symptoms he considers as indicating the extensive development of false membrane on the internal surface of the aorta. These cases are recorded in M. Bizot's Mémoire; and we insert them, in order that by directing attention to them, his views may be confirmed or modified by other investigators.

"A young physician, aged 27, with light blue eyes, brown hair, fair delicate skin, pale complexion, good constitution, residing in Paris since 1829, having never been attacked with any serious disease, had since that period complained frequently of loss of appetite, and occasional diarrhœa, but without emaciation or loss of strength. He was in the enjoyment of good health, when, in September 1833, he perceived, for the first time, that his legs were swelled. Rest in the horizontal posture produced no effect in lessening the œdema; but his appetite and strength remained unimpaired; his respiration was not hurried, even on ascending the stairs; there was no disturbance of the heart, which beat regularly, and with its usual force. He made light of these symptoms, employed no remedies, and pursued his occupations as before. The inappetency and diarrhœa had lasted eight days, when, on the 24th of October, after a long walk, he complained of great debility, with pain in the right iliac fossa, and a feeling of swelling in the abdomen. These symptoms were but the prelude to a severe rigor. He passed a restless night, and his strength, next day, was prostrated. The œdema, which till then had been confined to the lower extremities, had extended to the body, face, and arms. The pulse 120 to 130. In the two following days, the œdema diminished perceptibly; the stools had become solid, and with them was voided a fragment of a tænia; pulse 100, with exacerbation of the fever in the evening, but without rigor. Palpitation was complained of on the 26th, but never afterwards. The thirst was constant, and there was expectoration with a cough, which, however, had existed previously to the attack. During the two first days he was bled three times, to the extent of 16 ounces each time; Seltzer water, and other diluents, with ice, were also employed."

"28. Obliged to lie raised almost to the sitting posture, mind clear, no headache, voice strong, hearing unimpaired, no tinnitus, eyes natural, face pale and slightly œdematous, but without any expression of stupor. The body, as well as the upper and lower extremities, are infiltrated; the abdomen is meteorized; the skin is fair, presenting neither petechiæ nor sudamina, but covered with sweat. He has sufficient strength to raise the glass to his mouth, but can neither sit up nor change his place. He complains of his extreme debility, and pain in the armpits, when moderate pressure is made on this region. The tongue is moist, rose-coloured; the teeth are not dry, nor fuliginous; there is no nausea, no vomiting. The thirst is great, the colour of the pharynx natural, there is no pain or pressure on any part of the abdomen, no diarrhœa. The urine is scanty and high coloured. The liver does not project beyond the margins of the ribs; the size of the spleen is natural; the heart does not extend beyond its ordinary limits; the præcordial region gives a clear sound; pulse regular and full, 120; respiration 24 in a minute, vesicular to the right, both before and behind; sound clear on percussion on all this side. At the top of the left lung, and in front, the respiration is more feeble, accompanied with a sub-crepitant râle, and strong expiratory sound; the percussion is somewhat less sonorous than on the right side. The mucous expectoration is soft; in two or three, a few streaks of blood occur, but the spits are neither rusty, viscid, nor semi-transparent. (Digitalis and diuretic drinks ordered)."

"On the 28th, he passed an extremely restless night; pulse 125. Eight ounces of blood having been abstracted, he obtained relief and rest. At five o'clock, A.M., however, he was suddenly attacked with excessive and suffocating pain, just below the margin of the left false ribs. The application of fifteen leeches, *loco dolenti*, procured some alleviation; his intellect remained perfect, although he wandered continually; pulse 120, regular and full; respiration but slightly affected; tongue moist, rose-coloured; thirst still great. No increase of the œdema since yesterday; urine scanty and turbid; abdomen greatly meteorized. At eight o'clock, A.M., the pain shifted to the præcordia, and became much more intense. Fifty leeches were applied, and the pain soon ceased, but was followed by convulsions which only lasted a short time. His strength declined rapidly; countenance cadaveric. During the day, an opiate procured sleep; the breathing frequent, plaintive, and irregular. Towards evening the pulse became very feeble, and all the symptoms aggravated, although he did not seem to feel any local pain. His intellect remained unimpaired to the last moment. He expired on the 30th, in the morning."

"Autopsy twenty-eight hours after death:—Infiltration considerable in the upper extremities, still greater in the neck, which is of a violet colour, more on the left arm than on the right, moderate in the body and thighs, and slight in the legs and feet; abdomen very much meteorized; embonpoint unaltered; skin tinged slightly yellow, and slightly ecchymosed on the back; strong smell of putrefaction, no cadaveric rigidity. The pericardium contained four or five ounces of brown serum. The lining membrane of the anterior surface of the right ventricle, and the opposite wall of the pericardium, were studded, to the extent of two inches, with small soft yellow granulations, of the size of grains of sand; these could be easily torn off, and beneath them the serous membrane did not present any appearance of injection."

"The heart of full size was extremely flaccid, and could be torn without difficulty; the left ventricle was quite empty, its internal surface was of an ashy colour, presenting, near the aortic valves, small granulations, and a very thin, soft, yellowish membrane, which peeled off without difficulty, giving a rough appearance to the surface on which it had been formed; this exudation was also spread on the aortic valves, which, though of a deep red, were still flexible. The aorta, throughout its entire length, was of a deep violet colour; no capillary vessels, however, could be distinguished, nor did it contain either fluid or coagulated blood. The same granulations, and false membranes, were found in greater or less quantities throughout the whole length of the vessel, giving to its internal surface an unpolished appearance; they could also be detached with the same facility. Similar alterations were found in the left crural artery; that of the right side was of a violet red, but without granulations, or false membrane. The carotid and subclavian artery, though red, were healthy. The orifice of the aorta was natural, all the valves of the heart were flexible, the pulmonary artery, though red, was smooth and polished. In the right ventricle, there were no granulations, and very little blood; even in the right auricle, there were but a few small clots; the vena cava, the iliac and crural veins were also empty. Each pleura contained from four to five ounces of reddish serum. The right lung was free, the left was united laterally at its upper part to the pleura, by old bands of adhesion. There were neither tubercles, nor grey granulations, nor hepatization in any part of the lungs. There was slight emphysema along the thin edge of the left lung; both lungs contained generally more than the usual quantity of blood, but there was no softening of their substance. The bronchial tubes generally were pale; the bronchial glands, soft, deep-coloured, but not tuberculous; the cervical were twice their usual size, soft, and of a greyish violet colour. The trachea was of a violet colour also, but without any other lesion; the larynx was perfectly healthy. With the exception of an ounce or two of limpid serum, there was no effusion into the cavity of the abdomen; the peritoneum was perfectly smooth."

"The stomach contained a little mucus, and was distended with gas; its mucous membrane generally was of a greenish grey colour, with some darkish patches along the lesser curvature; its consistence was firm, and thickness natural. The duodenum had a greyish hue; the jejunum greatly meteorized contained a little yellow mucus, with long and numerous fragments of tænia; its mucous membrane presented a few bluish arborizations, but was not much injected. Towards the end of the ileum, there was slight emphysema, but its consistence and thickness were natural; the glands of Peyer were bluish, dotted with grey, but not prominent; in the lower part of the intestine, numerous isolated follicles of the size of millet-seed lay scattered. The mesenteric ganglions were soft. There was some submucous emphysema in the cæcum; its lining membrane was greyish, thin, and soft, tearing in shreds half an inch long. In the rest of the intestine, the mucous membrane was also greyish, but there was neither injection nor emphysema; on tearing, it gave shreds an inch long, the mucous follicles were visible throughout. The bladder contained a little brownish fluid; its mucous membrane was pale. The cortical substance of the kidneys of a greenish hue was emphysematous, and on peeling off the fibrous envelope tore with it; the tubular substance was firm and of a violet colour. Under the peritoneum, covering the liver, were several emphysematous elevations; the organ itself was bulky, somewhat soft, and contained a saneous fluid, rather than blood; its parenchyma was of a pale green, and exhaled a strong odour; the gall bladder was full of bile of a golden yellow. The spleen was four inches long, slightly emphysematous, very soft, and of a deep brown colour. The head was not examined; but this does not affect the value of the case, as there were no cerebral symptoms observed during the disease, and, therefore, excepting the traces of pericarditis, which evidently had occurred on the 29th, there were no other lesions of importance but those observed in the arterial system, so that if we had nothing else but the description of the organs to enable us to form an opinion as to the cause of death, we should be compelled to ascribe it to an affection of the aorta."

All the circumstances of this case, it will be observed, had been closely watched, and even the existence of the false membrane had been indicated before death by M. Bizot to the other physicians who were in attendance with him. The diagnosis might have appeared a bold one, but he felt authorized to offer it, from his having previously, and in the course of his researches on this interesting subject, observed two other cases marked by the same peculiar symptoms, sudden acute œdema, with high febrile action, without any disturbance of the heart, or of the other important organs. To this assemblage of symptoms, therefore, taken in connexion with the existence of a false membrane covering the internal surface of the aorta, notwithstanding the smallness of the cases in support of his opinion, M. Bizot does not hesitate to apply the name of acute aortitis.

The exudation of acute character may vary, however, from the description given above, being, in some instances, more intimately adherent to the lining membrane, more firm, and of a milky white. Sometimes these patches resemble the hard boiled white of egg, and present the hardness of cartilage; in the latter case, the lining membrane can no longer be found. That they severally commence in albuminous effusion cannot, however, be doubted, for if, while in the soft state, they be subjected to ebullition, the most transparent of these exudations become firm, opaque, and white. Some authors have described them as being developed between the internal and middle tunics, but this is erroneous, as may be shown, by peeling off the latter with great care: the shred stops or breaks off suddenly on arriving at the edge of the cartilaginous patches, and cannot be continued over its surface. In regard to these cartilaginous patches, another error is prevalent, viz. that they ultimately become osseous. Now if such transformation ever occurred, the stages of the transition must surely be detected; but this is not the case. The source of this error will be pointed out hereafter. The last peculiarity of these exudations which requires to be noticed is, that they occur most commonly before or about the middle period of life, contrasting in this respect with other alterations of structure of the arteries, to be described hereafter.

We have now to notice another form of alteration, occurring in the arterial tunics, which, though presenting itself in specks and patches of variable extent, differs from the species above described, not only in its origin, but in its mode of development, and ultimate consequences. The alterations now under consideration, may be observed even in subjects under puberty, presenting themselves singly or in groups, as small specks or dots of the size of a grain of sand, and of a whitish yellow colour, round or near the orifices of the coronary, innominate, carotid, subclavian, and intercostal arteries. They are not elevated upon the surface of the internal tunic, but are seen through it, as neither the transparency, nor the consistence of this membrane is in the slightest degree affected by their presence, at least, while in this, which may be considered, their *rudimentary* state. If a shred of the membrane be detached and torn towards these yellow spots, the spots peel off with it, being slightly adherent to its external surface; but if the same attempt be made, after the spots have become confluent, and formed a patch of some extent, the yellow substance then adheres partly to the outer side of the shred, and partly to the middle tunic; hence it is obvious, that these yellow spots are developed neither on the internal, nor on the middle tunic, but between both. When they attain a certain size, as they frequently do in old age, they undergo various transformations, of which, ulcerous, or rather atheromatous softening and ossification are the principal.

The process of softening presents various stages. In the first, the internal membrane covering the patch is still unaffected, but the internal fibres of the middle coat, on which it rests, are more or less altered according to the degree of advancement which the process has attained; these fibres are softened, and differ in colour, being of a brighter yellow than the sound parts of the same coat. The patch itself appears to be slightly elevated, but there is neither redness nor injected vessels in its vicinity.

In the second stage, the patches are elevated, like pustules of an irregular or rounded shape, on the surface of the aorta to the height of a line or two. The internal membrane is still thin, transparent, and unaltered. On pressing these eminences gently, the finger perceives the movement of a semi-fluid matter. If the pressure be increased, the lining membrane gives way, and a yellow matter escapes, which resembles healthy pus ; sometimes this matter is either moist or dry, and as it were farinaceous, or the mass seems as if it consisted of a quantity of minute, thin, shining spangles, some of them of a silvery, some of a golden hue. The matter being evacuated, the pustule disappears, and the internal membrane is depressed in the place it occupied. On removing this membrane, the internal surface of the middle tunic is found ulcerated, softened, and reduced to a firm, moist, yellowish detritus ; several of the laminæ of this tunic are thus altered, but the healthy structure still exists towards its most external layers.

In the third stage, the pustules having emptied themselves spontaneously, small irregular depressions, with edges slightly elevated, are observed. The surface of these depressions is smooth, but exhibits here and there fissures or cracks. On removing this internal membrane, the softened matter and the alteration of the middle tunic just described will be found. In some instances, the internal membrane has disappeared, and the blood is in contact with the middle tunic.

If we now compare these several lesions together, we must at once perceive that they are nothing more than degrees of one and the same alteration, which originated in the small point which was first observed between the internal and middle tunics, and which at a later period becoming fixed to the latter, passed through the stages above described. M. Andral has described these pustules as small abscesses, but although the matter they contain has some resemblance to pus, it differs totally from it in the mode of its formation, and has a much greater analogy to that of softened tubercle.

The succession of these changes proves to demonstration that the alterations described under the various names of spots, pustules, abscesses, atheromatous, and steatomatous productions, &c. have one common origin, to wit, the almost imperceptible spot, developed without any trace of inflammation between the innermost and middle tunics of the arterial tube. Morgagni and Haller had already remarked this series of transformations, but they had included in it, the cartilaginous patches, the origin of which, as has been shown, is totally different. They fell into the same error, as regards the osseous productions ; and this is easily accounted for, as very frequently both the atheromatous matter, and the osseous productions, are abundantly developed beneath the primitive cartilaginous patches. It may be here remarked, that out of the great number of ulcerations of the middle tunic, observed by M. Bizot, he only met with one, in which there was a commencement of aneurism ; in all the others, there was always a layer, in some cases, no thicker than a leaf of paper, of the middle tunic remaining ; in the case in which this membrane had entirely disappeared, there were partial dilatations on the arch of the aorta, corresponding to the points where the middle tunic was wanting. Writers have described steatomatous productions of the arteries. It is, however, unnecessary to repeat their statements on this subject, as these tumours are now considered by Mr. Hodgson and most modern authorities, as nothing more than aneurismal sacs, that have undergone spontaneous cure by the deposition of coagulable lymph.

Osseous Transformation:—The transformations of the primitive patches do not always follow in the order above described. Sometimes a hard semi-transparent point, of the same colour as the patch itself, forms in its centre, and increases slowly, more in extent than thickness, till it alters the structure of the middle tunic, as has been already described. The surface in contact with the lining membrane increases less rapidly, and a long period elapses, even when the osseous disk is of some size, before any remarkable change can be observed in this membrane. In some cases, however, it seems to be slightly thickened by a layer of albumen spread over the concretion. Ultimately, even this membrane is destroyed by the progress of the ossification, which then is in immediate contact with the blood. The yellow soft matter always surrounds the concretion, but no fibres can be discovered where they are in contact, the fibrous structure of the middle coat can only be detected by proceeding from the circumference of the concretion towards the sound portion of the artery. It is in the advanced period of life that these concretions are most commonly formed. But they have also been discovered in subjects of tender age. Mr. Hodgson mentions a case observed by Mr. Young, in which the temporal artery of a child only fifteen months old was found ossified, and Wilson met an instance of ossification in the aorta of a child only three years old. Bichat supposed that ossification never occurred in vessels through which black blood only circulated, and consequently that these concretions were not observed in the pulmonary artery. This, however, is erroneous. The instances, it is true, are very rare, but they have been observed, nevertheless, by several pathologists.

These concretions sometimes occupy the entire circumference of the vessel, but they do not form prominences on the surface of the arterial tube ; they are often found surrounding the origins of the smaller arteries, and in such cases, they have the appearance of a ring, or if more extensive, of a hard cylinder, through the centre of which the vessel passes. It would seem, therefore, that the yellow patches undergo two different kinds of transformation, the ulcerous and the osseous; the latter, however, ought not, as Haller and Morgagni imagined, to be considered as a transformation, but rather as a simple deposition of phosphate of lime, occurring in the soft yellow matter, which, as Mr. Guthrie expresses it, forms its nidus.

But notwithstanding an undoubted difference of origin, the cartilaginous patches may be found in the same spot simultaneously with the ulcerous softening of the middle tunic, and the osseous concretions, and indeed their coexistence is by no means unfrequent. It is on this account, that some authors have supposed that the cartilaginous concretions were sometimes transformed into the osseous. On a careful examination, however, the error may be detected, as the ossification is never found, even beneath the white patches, without being surrounded by the yellow matter.

When these lesions occur in vessels of small size, the atheromatous matter is often so abundant, as to thrust the cartilaginous patches towards the axis of the vessel, thus diminishing its calibre, while at the same time it attenuates the middle tunic sometimes to a considerable degree, by the pressure which it makes upon it[1]. The effects thus produced upon the large and small arterial tubes, are very different; in the small ones, the albuminous secretion will tend to their obliteration, not so much from its own nature, as from the abundance of atheromatous matter, the deposition of which, in some cases, it seems to determine between the two internal tunics: obliterations of this kind are sometimes seen in the arteries of the inferior extremities. In the large vessels, on the other hand, the extensive development of the cartilaginous patches produces a different effect. Here, though the deposition of the atheromatous matter is in proportion less abundant, it involves more completely almost the entire thickness of the middle tunic, and hence the elasticity of the vessel is impaired, in the first place, by the extensive disorganization of the fibro-elastic coat; and in the second, by the development of the cartilaginous layer, which is itself inelastic. The large vessels in this state are reduced to the condition of almost inert tubes; their coats yield to the distending force, but are incapable of contracting again, and this doubtless will account for those considerable dilatations of the arch of the aorta, which are observed to occur without any aneurismal tumour.

M. Bizot had met but one case in which the middle coat was completely destroyed. The subject was a female forty-five years of age. The internal surface of the aorta was studded with cartilaginous patches, and there were several small aneurismal tumours on its external surface. On examining these tumours, the cavity was found lined with a thin membrane which was in contact with the cellular coat; the latter appearing almost transparent, and quite healthy, but the middle coat had entirely disappeared. M. Bizot, although he assents to the received opinion that the occurrence of aneurism is intimately connected with the morbid alterations of arteries, and the application of occasional causes, such as falls, blows, fits of passion, &c. nevertheless thinks, that other causes, the nature and action of which are still unknown, may operate in its production. He justifies himself in propounding this idea, on the observation of a fact, which we shall notice by and by, and which he terms the symmetry which seems sometimes to preside in the development of these morbid alterations.

Alterations peculiar to the arteries of the limbs:—These first appear as minute stains; they adhere to the middle tunic, and cannot be torn off with the lining membrane. Becoming multiplied they extend round the artery like a zone, and seem to be slightly depressed below the general surface of the cavity of the vessel; their adhesion to the middle tunic is so firm, that they cannot be separated from it, like the yellow patches in the large arteries, when we tear off a shred of the lining membrane. The fibres of the middle tunic at these points appear to be yellower, harder, thinner, less pliant, and more resisting. The transformation commencing immediately beneath the lining membrane, which it never affects, extends outwards through the layers of the middle tunic. The fibres at length are changed into depressed osseous, lines, which uniting, complete the entire circle of the vessel, and extend to various lengths upwards and downwards along its course. When the ossification of the middle tunic is complete, the artery is reduced to the condition of an inert tube, the external and internal tunics which are healthy merely covering both its surfaces. In undergoing this transformation, the middle tunic is diminished in thickness, so that the diameter of the artery becomes actually larger.

If we now compare this alteration with that already described, it will be found that they differ not only in their origin, but also in the transformations which they respectively undergo. The one originates in the minute yellow spot developed between the internal and middle tunics: the latter of which becoming thickened and softened, ultimately presents either the *ulcerous*, or the *osseous* transformation. In the other, the middle tunic alone is attacked, and ultimately becomes thin, transparent, and ossified. Instances, however, have been met with, where these two forms of alteration were found together, patches of the atheromatous matter extending beneath the lining membrane, and externally to them, the middle tunic being hardened, or converted in circular bony rings.

All these alterations generally increase in number and extent with the age of the individual, so that in advanced life, scarcely any subject is entirely free from them. Their effect upon the arteries, as we have already stated, is gradually to impair their pliability and elasticity, until they become totally incapable of either contracting or expanding. Now, this must affect to a considerable extent, the circulation of the blood within those vessels. The arterial tube has become inert, its surface rough and uneven, and its diameter enlarged. The movement of the blood is thus retarded, and as the force of the heart's contraction, instead of being in part spent, as formerly in dilating the large arterial tubes, is now transmitted entire to the smaller vessels, the blood is sent into the delicate structure of the remote organs with much greater force. In this way, doubtless, we may explain the augmented impetus of the pulse in persons who have attained a great age, and possibly this cause may contribute not a little to the production of those cerebral hæmorrhages so frequent in aged people.

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[1] Mr. Hodgson mentions a case in which he found the emulgent and femoral arteries thus obliterated from the great quantity of the atheromatous matter.

In the course of M. Bizot's researches, he was struck with the fact, that whenever he found a lesion in an artery on one side of the body, the same kind of lesion would in all probability be found at the same point of the corresponding artery of the opposite side. With some exceptions, which might be easily accounted for, this symmetrical development of lesions was so constant, that he does not hesitate to characterize it as an invariable law in morbid anatomy.

TORTUOSITIES OF ARTERIES.

After the arterial blood is expelled from the heart into the aorta, it continues to circulate with the same velocity through the vertebral arteries and some of those primitive trunks contained within the thoracic and abdominal cavities, as that with which it was expelled from the central organ. Afterwards the velocity of the stream of blood undergoes various modifications in different vessels, which is necessary for the performance of the particular function of those organs in which such modifications are observed. Thus different organs are supplied with very different quantities of blood in proportion to their bulk, and in some the quantity varies even at different times. In some parts of the body, such as the tendons, the ligaments, and the muscles, they receive only such a quantity of the sanguineous fluid as is necessary for their nutrition, whilst the secreting and excreting glands are supplied with a quantity proportioned to the activity of their functions. The quantity of blood necessary for the stomach is different at different periods of the digestive process, and in the organs of generation it varies at different times, increasing or diminishing according as those organs are called into action. In order to effect these purposes in the circulation, the arteries are distributed in a variety of modes. Besides anastomoses, and the different angles at which arteries come off from the trunks, the different length of some arteries from the point at which they leave the trunk, until they reach the organs to which they are destined ; their different positions in relation to surrounding parts ; the tortuosities or flexures of arteries is another peculiarity by which the momentum of the circulation is modified in certain organs. The tortuosities of arteries have been generally supposed to have the effect of diminishing the velocity of the blood which is sent to particular organs, and though the serpentine course of an artery will, to a certain degree diminish the momentum of the blood, yet if the arterial canal be kept constantly full, the motion communicated to the blood by every contraction of the heart will be as great at the extremity of the tube as at its origin, except only an almost incalculable degree of loss caused by the increased friction of the blood, on the sides of the arterial tube, from the length of the windings of the canal. The impulse therefore which the central organ of the circulation communicates to the blood sent to any particular organ, must not be estimated according to the course or direction of the vessels which carry the blood, and the tortuosities observed in particular arteries, must therefore be intended to perform an office different from that of merely diminishing the velocity of the current of the blood. In order to ascertain what may be the effect of a serpentine course of an artery, we should enquire into the functions of those organs which are supplied with tortuous vessels. Some rectilineal arteries become tortuous when they are much distended, as may be observed after an artery is obliterated ; in which case the collateral branches, besides increasing in size, also become more or less tortuous, or when an artery in the dead body is forcibly injected with a fluid, it in like manner becomes tortuous.

The arteries of the uterus have numerous flexures, which increase in proportion with the growth of the uterus during gestation. " They increase in size and in length before they reach the uterus, which obliges the spermatic artery in particular to be thrown into a serpentine form. This is more remarkable in some animals than in women." (*Hunter*)— In all these different cases of tortuosities of arteries, it appears probable that the flexures in the vessels are only the necessary consequence of its elongation ; and their elongation being caused by the new growth of the part which the artery supplied, and not for any purpose of modifying the velocity of the blood. In a like manner may we account for the serpentine course of the spermatic arteries, their tortuosities being occasioned by the testis descending and elongating the artery. There are also tortuosities in vessels which are distributed to parts subject to alteration in their position, and to organs which are liable to great distension.

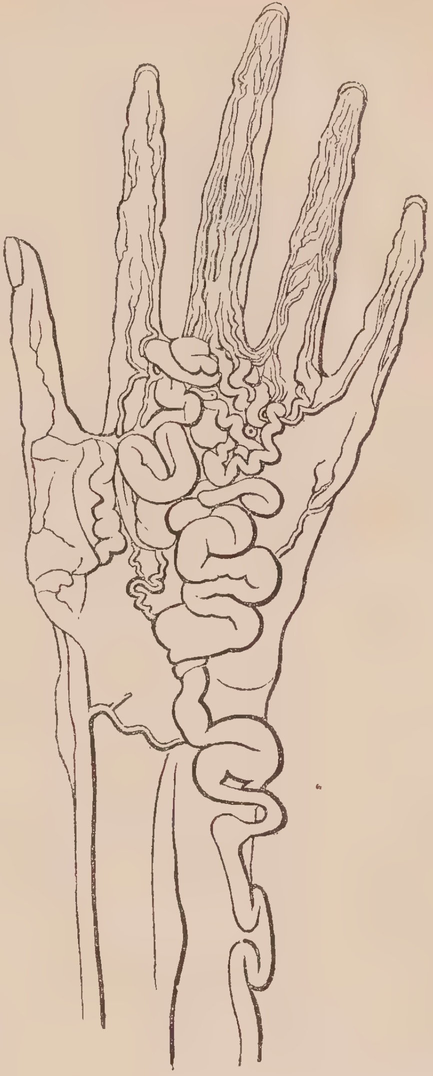
We have an example of the first condition in the face and lips—in those of the iris, intestinal canals, and likewise in the curvatures of the vertebral arteries, on their entrance into the cranium. The almost unceasing movements and change of position in these parts would compress and alter the form of the artery, and disturb the equality of the circulation, did not the vessels by their serpentine course readily accommodate themselves to such changes. Besides this influence of a tortuous course in an artery, there is another important effect produced by it on the circulation, and of which there are many examples to be found in the lower animals as well as man. The tortuosities of the vertebral arteries not only permit the various movements of the head on the vertebral column, without the circulation within the head being disturbed, but it is evident also they will prevent the weight of the column of blood, when the head is bent downwards, causing any pressure on the brain. After refuting the opinion of those physiologists who suppose the curvature of the vertebral arteries to have the effect of diminishing the impetus of the blood in the brain, Bichat concludes,—"Thus I am ignorant of the connexion which exists between the curvature of the cerebral arteries and the circulation of the blood within the head."—(*Anatomie Descript.*) In the lower animals there are many examples of arteries which have a tortuous course, in order to fulfil a similar purpose in the circulation of organs, which would be, more or less, subject to disturbance from the peculiar habits of the animal, if the pressure of a column of blood on such organs was not guarded against. There is a remarkable example of this in the spermatic arteries of the bull, and in the carotid and vertebral arteries of graminivorous animals, whose heads are necessarily much in the depending posture.

DILATATION OF ARTERIES.

The arterial varix, is a diseased condition of the arteries, which is very different from a true aneurism. In the arterial varix, not only is the whole circumference of an artery preternaturally dilated, but the enlargement sometimes extends along the whole artery of a limb, as well as many of its ramifications, or the trunk of an artery, such as the temporal, or occipital, with numerous branches, becomes so dilated as to form a tumour composed of a congeries of dilated vessels. The artery, in some instances, enlarges very considerably, acquiring many times its natural diameter, preserving its cylindrical form, and being equally dilated in every part. The tunics, in place of becoming thinner, as in simple dilatation, acquire additional thickness.

In the accompanying fig. is represented an arterial varix in the arm of an aged female. The ulnar artery enlarged and tortuous, and the radial artery also enlarged and lengthened. Both these arteries are seen forming several circumvolutions on the palm of the hand,—which anastomose and form globular aneurismal swellings.

Fig. 110.



(*W. B. Costello.*)

ANOMALIES OF ARTERIES.

There are several deviations in the origin and course of the principal arteries, with which it is necessary that the surgeon should be familiarly acquainted.

REGION OF THE HEAD.

The facial or external maxillary artery is sometimes so small as scarcely to pass beyond the angle of the jaw; at other times it extends to the forehead, and furnishes the lachrymal, palpebral, and frontal arteries. In the latter case, the surgeon might fall into error, by placing a ligature on the wrong trunk, were the frontal artery to be wounded. The facial artery may also ascend much nearer to the mental symphysis than is usual. M. Robert describes a peculiar disposition of the transversalis faciei, which deserves to be noticed in connexion with operations on the parotid duct; this vessel was double, one artery being placed above, the other below the duct, and both communicated by two small transverse branches. The transverse artery of the face arises, in some rare cases, from the external carotid, and crosses obliquely the masseter muscle to gain the angle of the mouth. The lingual artery is seldom the subject of operation, though it has sometimes been tied preparatory to extirpation of the tongue. It may arise by a common trunk with the superior thyroid, or more frequently with the facial artery. M. Maingault has endeavoured to determine the exact point at which the lingual arises; of thirty-six subjects examined by him, for this purpose, he found that the vessel was given off at the level of the os hyoides in twenty-one; and from one to eight lines above it in fifteen subjects. Two ranine branches of the lingual artery have also been found, a circumstance which would render an accident more likely to occur in bleeding from the ranine veins in glossitis.

CERVICAL REGION.

The great vessels in the cervical region are subject to numerous deviations, many of which would materially interfere with the practice of certain operations in this part of the body. The latter only will be noticed in the following remarks. The common carotid artery usually divides into internal and external branches, near the superior edge of the thyroid cartilage, but the bifurcation may take place much higher up, near the base of the cranium. In other cases it divides as low down as the sixth cervical vertebra, and then two large vessels, of nearly equal size, are found ascending in the ordinary course of the common carotid artery.

The thyroid arteries present numerous deviations, both in origin and course. The superior thyroid arteries are occasionally much enlarged, in consequence of the inferior thyroidal vessels being absent; the artery, again, may arise, much lower down than it usually does, from the trunk of the primary carotid. Zagorsky relates an example of the former occurrence, where the superior thyroid on the right side was nearly as large as the external carotid. In a case which is recorded in the Memoirs of the Russian Academy of Sciences, the superior thyroid arose about an inch below the bifurcation of the carotids; it was nearly twice its ordinary calibre, and as it ascended close upon the common carotid trunk, might easily have been included with the latter in a ligature. The branches distributed to the thyroid gland were very large and superficial, being merely covered by the skin and platysma myodes. This latter circumstance, as M. Robert justly remarks, should render the surgeon cautious in opening all abscesses situate in the upper and anterior region of the neck.

The origin and course of the different branches of the inferior thyroid artery are extremely various. Burns describes the two inferior thyroid arteries as arising by a common trunk from the subclavian or arch of the aorta, and ascending in front of the trachea to the thyroid gland. Manec has seen this common trunk given off by the left subclavian. In other cases the vessels, which are usually branches of the thyroid artery, arise separately from the subclavian artery, or innominata. In a good example of this distribution, which is preserved in the museum of Guy's Hospital, the left inferior thyroid was a branch of the innominata, and crossed obliquely over the front of the trachea to gain the left lobe of the gland. Besides the inferior thyroid artery there exists very frequently a vessel described by Neubauer under the name of thyroidea ima, and by Harrison under that of t. media. It usually arises from the arch between the innominata and left carotid, and ascends straight on the trachea to the thyroid body. It may, however, be furnished by the innominata or primary carotid. In a case detailed by Burns, this anomalous branch was larger than a crow's quill, and ascended between the sterno-thyroid muscles to the lower border of the thyroid gland at the left side; it was accidentally wounded during the operation of œsophagatomy, and gave rise to a serious hæmorrhage.

It is scarcely necessary to point out the influence which the deviations just described must necessarily exercise on all operations performed in this region of the neck.

The anomalies of the great vessels which arise from the arch of the aorta are now familiar to most anatomists. They amount, in the aggregate, to nearly forty different modes of origin, but we have only to consider those which may concern the surgeon in the practice of his art.

The right subclavian artery, instead of being a branch of the innominata, may arise from any portion of the arch of the aorta, even as low down as the descending arch, an example of which the writer once met with in the dissecting room of Trinity College, Dublin. In such case the right subclavian may cross the front of the trachea obliquely towards the right side at any point between the sternum and lower border of the thyroid gland. Thus Burns relates a case, in which the vessel passed in front of the trachea immediately beneath the lower edge of the gland; and Walter has recorded an unfortunate operation of tracheatomy performed on the daughter of a celebrated professor of surgery, where the child died under the hands of the surgeon, in all probability from a wound of the subclavian or other great vessel which pursued the anomalous course just described. In other cases, the right subclavian artery passes between the trachea and œsophagus, instead of crossing the former in front, or it may rest on the bodies of the vertebræ, being covered by the trachea and œsophagus. In either of the cases now mentioned, an alteration in the calibre of the vessel may act as an impediment to deglutition, or the artery may be wounded by a foreign body in the œsophagus. Mr. Kirby has related a very remarkable instance of the latter, in the Dublin Hospital Reports. A woman swallowed accidentally with her food a fish-bone. She was soon seized with symptoms of suffocation, &c. Tracheatomy was performed, but the patient died of hæmorrhage which seemed to proceed from the œsophagus. On examination after death it was found that the right subclavian artery, which passed from the arch towards the right side, between the œsophagus and vertebræ, had been perforated by the foreign body.

In some cases, which the continental anatomists describe as not being of very rare occurrence, the left carotid artery is a branch of the innominata, and crosses immediately in front of the trachea, below the thyroid body to the left side of the neck. In one example which we met in the dissecting-room of Trinity College, Dublin, all the great vessels arose from the left side of the arch. The right carotid was the first branch, and crossed the lower part of the trachea, giving off the right vertebral artery as it passed. The left carotid and subclavian arteries were detached, nearly from the same point, to the left of the right carotid, while the right subclavian was given off from the descending arch, and passed to the right side behind the œsophagus and trachea. Finally, we may observe that in a very few rare cases the subclavian artery passes in front of the scalenus anticus muscle, the vein behind it; the relative positions of the two vessels being thus reversed [1], and that after it has emerged from beneath the scalenus muscle, the subclavian is sometimes completely enveloped by the axillary plexus of nerves, a circumstance which would greatly increase the difficulty of tying the vessel.

The vertebral artery (particularly the left) may arise from the arch of the aorta and ascend along the neck for a considerable way before it enters the foramina of the cervical vertebræ. We have seen it enter as high up as the fourth, and we have Sœmmerring's authority for stating that it may enter the second cervical vertebra. In such a case the vertebral artery might be mistaken for the primary carotid, or included in the same ligature with the latter vessel. Such disposition would, also, increase the danger of all incised wounds of the neck, &c. Burns has related an instructive case of this kind. The left vertebral artery arose from the arch; the right was given off by the subclavian, and ascended immediately behind the carotid artery and on the rectus anticus muscle, as far as the foramen of the third cervical vertebra, through which it entered. Sometimes the trunk of the vertebral artery is formed by the union of two branches from the subclavian, or from the subclavian and arch, or we may have three distinct branches uniting to form the vertebral, an example of which is related in Meckel's Archives.

The disposition of the vertebral artery to which allusion has just been made, and its course along the neck, only separated from the common carotid by a thin slip of fascia, might, as A. Burns remarks, render it a matter of some difficulty to distinguish an aneurism of the vertebral from one of the primary carotid artery, but the surgeon, acquainted with the varieties of the arterial system, would immediately detect the source of error by alternately compressing either vessel, and observing the effect produced on the aneurismal tumour.

The arteries of the upper extremity present a great variety of anomalies, which are interesting to the surgeon. Passing over those of the circumflex arteries, and arriving immediately at the brachial, we find that this vessel, instead of dividing into two branches at the bend of the elbow, may bifurcate at any point between the elbow and the axilla. This high bifurcation of the brachial artery occurs very frequently, and is much more common than any other anomaly to which the vessel is subject. It may take place just above the bend of the elbow, in the middle of the arm, or so high up in the axilla as to furnish, from the radial branch, the long thoracic artery. The manner in which the division into two branches takes place, also, varies much. Sometimes both are of equal size, run down close to each other along the inner edge of the biceps, and separate near the elbow-joint to become radial and ulnar arteries. In many other cases, the branches are of very unequal size; one is nearly as large as the brachial in its ordinary state, and follows the usual course of that vessel; the other, which proves to be radial, is small, is detached from the side or front of the main trunk, and usually runs for some way along its inner side, before it passes over to the radial side of the arm. In other cases, the radial arises from the inner side of the brachial near the upper third of the humerus, and immediately winds over the trunk to gain the other side. In the cases now described, of all of which the writer has seen numerous examples, the radial artery is usually covered by the tendinous fascia of the upper arm, but in a very few instances it pierces the brachial aponeurosis and becomes superficial. In high bifurcations of the brachial artery, the radial is sometimes joined to the ulnar at the bend of the arm, by a transverse branch of considerable magnitude, which furnishes the radial recurrent. Two very remarkable examples of this distribution are represented in the writer's work on the varieties of arteries. Tiedemann has also represented this anomaly. In one subject which we saw at Clamar, in 1834, the transverse communicating branch joined the ulnar and radial arteries at the lower third of the fore-arm. It may be remarked, that the transverse communication just described, which exists as the normal distribution between the arteries of the corpus callosum, has been found between the vertebrals, just before they form the basilar; between the primary iliacs, near the bifurcation of the aorta, and between the posterior tibial and fibular arteries, at the lower third of the leg.

Near the lower third of the fore-arm the radial artery sometimes turns round the radius, descending along the posterior surface of the bone to the interval between the first and second metacarpal bones. In cases of this kind no pulse can be felt at the wrist, and if the surgeon were to cut down between the flexor carpi radialis and supinator longus muscles, he would find a comparatively insignificant branch (superficialis volæ) instead of the principal artery. Mr. P. Bennet Lucas has described an example of this kind which fell under his notice at the North London School of Medicine. "The radial immediately after its origin sent off the superficialis volæ, which was very delicate, and occupied the position of the radial artery. The radial trunk itself ran very superficially, and at the junction of the middle and inferior thirds of the fore-arm, turned round the edge of the radius to the space between the metacarpal bones of the thumb and index finger."

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[1] M. Blandin has given the particulars of a case in which the subclavian vein passed with the artery *behind* the scalenus anticus muscle. Here the surgeon might have included both vessels in the same ligature.

THE ULNAR ARTERY.

The ulnar artery is much less liable to present anomalies in its origin or course than the radial. When the ulnar arises above the bend of the elbow it is usually given off from the upper part of the brachial artery or even from the axillary, and, according to Burns's authority, which however is at variance with our own experience, it commonly descends along the inner side of the arm, and *above* the fascia to the palm of the hand. In such a case as this the artery might readily be wounded by a careless operator during venesection, and it seems probable that in most instances where the artery has been injured, an anomaly existed similar to the one just described. In some rare cases, the ulnar artery, even when it arises at the bend of the arm, penetrates the fascia, and accompanies the basilic vein to the wrist, or as happened in a case described in the Archives Gén. (March 1824), it passes superficially for the upper third of its course, and then dips under the fascia and palmaris longus muscle. Anomalies of the interosseous artery are still rarer than those of the radial or ulnar artery. Sometimes the interosseous artery is detached from the upper part of the humeral and descends with it to the bend of the arm, in which case it might be mistaken for the radial or ulnar arteries. Sometimes the brachial subdivides, high up, into three branches of nearly equal size, which eventually prove to be radial, ulnar, and interosseous arteries. In two very remarkable cases, which the writer examined in Trinity College, Dublin, the interosseous terminated by anastomosing with the radial near the wrist-joint.

The preceding are the chief anomalies affecting the vessels of the upper extremity, which are of any importance in a surgical point of view. One or two more, however, remain for enumeration. The axillary artery sometimes divides into two branches, of equal size, which run down close to one another beneath the edge of the biceps, and unite near the fold of the arm. We have seen two examples of this disposition, which has also been found in the femoral and basilar arteries.

The vasa aberrantia are supernumerary vessels, sometimes of considerable magnitude, which arise from the subscapular, axillary, or brachial arteries, and terminate in the ulnar or (most commonly) radial. Cruveilhier has observed, that in many cases of this kind the brachial artery is situate at a greater depth than it usually is, and the vas aberrans runs either over the main trunk, or immediately beneath the brachial aponeurosis. Finally we have to direct attention to the occasional and not very rare existence of a median artery. This branch arises from some one of the arteries of the fore-arm, descends between the flexor sublimis and profundus, in company with the median nerve, and terminates in a great variety of ways in the palmar arch. In some instances which we have seen, this median artery was of very considerable magnitude.

REGION OF THE ABDOMEN.

The only arteries in this region, with the varieties of which the surgeon is concerned, are the epigastric and obturator arteries.

The epigastric has been sometimes wounded during the operation of paracentesis abdominis, but more frequently this accident is occasioned by the presence of some anomalous branch, or by some deviation from the usual course of the renal. Ramsay has recorded an illustrative case; the circumflexa ilii, which arose below Poupart's ligament, divided into two branches; one pursued the ordinary course of the circumflex: the other ascended between the abdominal muscles, in a line midway between the linea alba and the superior anterior spine of the ilium; this branch was accidentally opened during the operation of paracentesis, and gave rise to fatal hæmorrhage. An analogous case is related in Kleinert's Repertorium, November 1835, where the wounding of an anomalous branch of the epigastric was likewise attended with fatal consequences. But varieties of the epigastric and obturator arteries are infinitely more interesting on account of their relation to the various operative methods which have been proposed for the relief of strangulated hernia. Under ordinary circumstances the operation is not attended with much difficulty, but unfortunately both the epigastric and obturator arteries are so liable to deviate from their usual disposition, that the surgeon is embarrassed and perplexed by the multiplied irregularities which they present.

Thus, as M. Verpillat remarks, the epigastric artery, which usually arises at the level of Poupart's ligament, may be given off either *above* or *below* the femoral ring, within a space of three or four inches. In the first case, the artery might be pushed on the inner side of the hernial sac, and in the second it would necessarily be wounded in dividing the stricture from within outwards. In one very remarkable case which we have seen, the epigastric was given off by the profunda femoris below Poupart's ligament, and would have lain completely in front of the sac, in a case of femoral hernia. Gunz relates a case in which the epigastric lay so close on the upper part of the sac that it must have been wounded if the surgeon cut directly upwards, and he mentions two instances in which this mode of operating was followed by fatal hæmorrhage from a wound of the epigastric artery. Dupuytren endeavoured to avoid this accident by cutting that portion of the fascia lata which is attached to, and renders tense the crural arch, and, if we are to believe M. M. Roche and Sanson, never wounded the epigastric. But on the other hand the late Dr. A. Thomson, who for many years devoted himself exclusively to the anatomy of hernia, has assured us that he had positive proofs that Dupuytren wounded the epigastric artery on three several occasions, and M. Verpillat, the author of a well-written paper on femoral hernia, was informed by M. Robert, that he had examined the bodies of two persons who died from hæmorrhage under similar circumstances.

The obturator artery is as liable to irregularities of origin as any other in the body. The most common form is that in which it arises by a common trunk with the internal epigastric. According to Cloquet's experience, with which our own observations fully coincide, this occurs once in three times; according to Hesselbach even more frequently, or three times out of five. When the obturator arises from a trunk common to it and the epigastric, it may detach itself from the latter vessel either above, below, or to the outer side of the femoral ring.

In the last of the three cases just mentioned, the obturator crosses the external margin of the ring, and is liable to be wounded if the operator cut obliquely upwards and outwards. In the first case, it winds along the edge of Gimbernat's ligament, to which it approximates more or less closely, according to the length of the common trunk. Finally, when the obturator separates from the epigastric below the femoral ring, it is situate quite close to this latter, and sometimes passes through it to gain the edge of the pubis. These different varieties of origin and disposition are so multiplied and combined as frequently to lead to fatal accidents during the operation for strangulated hernia, even when performed by the most skilful and experienced hands. If, as some surgeons recommend, we divide Gimbernat's ligament freely, we incur a very great risk of wounding the obturator artery. Scarpa is of opinion that this occurred in the case related by Mr. Hey. A similar accident happened to Mursinna; the femoral ring was completely surrounded by an arterial circle; on the inner side lay the obturator; on the outer the epigastric, and both vessels crossed immediately in front of the tumour above. Although the fibrous coat of the obturator had been merely grazed by the knife, hæmorrhage supervened on the eighth day and carried off the patient. M. Breschet relates an analogous case, in which the occurrence of a similar accident was prevented by the caution of the operator, who divided Gimbernat's ligament to the extent merely of two lines. On reducing the hernia, and passing up the index finger, the pulsations of an artery were distinctly felt on either side of the ring. The patient died, and on examination it was found that the obturator artery lay on the inner side of the neck of the sac, and would have been divided had the incision been carried one or two lines further. The epigastric artery ran along the outer side of the sac, but was distant from it four or five lines; while the spermatic and supra-pubic arteries lay so much in front, that they would have been wounded by carrying the incision directly upwards.

The obturator artery, as we have already said, occasionally arises below Poupart's ligament, from the femoral. A good example of this kind was preserved in the Museum of Guy's Hospital. In such cases the obturator commonly ascends close on the pectineus muscle, and internal to the femoral vein, and consequently would be found behind the sac in femoral hernia, but we have seen two examples in which the vessel advanced so far forwards, and left beneath it such a space that a femoral hernia must have passed immediately behind it.

As in the operation for strangulated hernia, so also in that of lithotomy, do anomalies of the arterial system frequently give rise to fatal accidents.

"Hæmorrhage," says Boyer, "is one of the commonest accidents which occur during lithotomy. The blame is often thrown on the operator, or on the method of operation, which he may have adopted; but in most cases, unjustly, for the perineal arteries present such a multitude of varieties both in situation and course, that the most skilful surgeon can never be sure of avoiding them, no matter what mode of operation he may adopt."

The pudic artery, in its third stage, instead of lying close on the rami of the ischium and pubis, may approximate more or less to the median line of the perineum. Deschamps accuses Desault of having wounded the pudic in this stage, and adds, "that he has frequently seen arterial blood spout, at the first incision, from this vessel, or from some of its branches."

In some cases the superficial artery of the perineum presents the same anomaly as the pudic, and the same accidents result from its lesion. The dorsal artery of the penis, as was first observed by Winslow, and since by Burns, Monro, Meckel, and several other anatomists, sometimes arises from the obturator or some branch of the hypogastric, and having passed along the side of the bladder, penetrates the upper part of the prostate gland to gain the dorsum of the penis. In some cases, instead of penetrating the prostate, it runs along the side of the gland, and is then even more exposed to injury during the lateral operation. An anomaly of this kind was the cause of an unfortunate accident which occurred in the practice of the late Mr. Shaw.

The transverse artery of the perineum is sometimes double, and in a case described by M. Belmas, it arose from the internal pudic just below the lesser sciatic ligament, and passed over the bulb across the lines of the lateral and bi-lateral incisions.

LOWER EXTREMITY.

Anomalies of the arteries of the lower extremity are much less frequent in occurrence and less perplexing to the surgeon than those of any other region. The point at which the common femoral divides into deep and superficial femoral arteries is very uncertain. The profunda femoris usually arises from an inch and a half to two inches below Poupart's ligament, but Berard mentions a case, in which it was given off as low down as the middle of the thigh. In other cases it arises from the external iliac, one or two inches above the crural arch.

Sir Charles Bell operated for popliteal aneurism without success; on examining the body after death, it was found that the femoral artery divided immediately below the origin of the profunda, into two branches, which afterwards reunited in the tendinous canal of the triceps. The preparation of a similar variety is preserved in the Museum of the Dublin College of Surgeons. Sandifort mentions a case in which the femoral artery divided into posterior tibial and fibular immediately below Poupart's ligament. Ramsay met with an example of this division just above the edge of the popliteus muscle, and Portal saw the femoral continue its course as far as the middle of the leg before it divided into tibial and fibular arteries. Zagorsky has related a very remarkable case, in which the femoral gave off a superficial branch which descended along the course of the saphena vein to join the internal plantar. This branch, then, may be considered to be analogous to the median artery of the upper extremity. The remaining varieties of the arteries of the lower extremity merely require to be enumerated. The anterior tibial sometimes terminates on the back of the leg, its branches being supplied by the posterior tibial. Pelletan describes a case in which the anterior tibial ran immediately underneath the skin to the ancle. The posterior tibial may sometimes be wanting altogether. In one very curious case, which occurred in the dissecting-room of Trinity College, there were two posterior tibial arteries.

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(P. Hennis Green.)

ARTERIOTOMY (τομή, 'a section.') The operation of opening an artery (in general the temporal) in order to abstract blood. See Bleeding.

ARTHRITIS, TRAUMATIC.—According to the definition commonly received among surgeons, the wound of a joint consists in the opening of the synovial capsule. A theoretic objection might be raised to this definition, on the ground that it includes only wounds of the more complex articulations, but for practical purposes it may safely be adopted, since the wounds of fibro-cartilaginous joints, such as those of the vertebral bodies and pelvic bones are of extremely rare occurrence, and are unattended by peculiar symptoms. It will, therefore, be understood, that this article is devoted to the consideration of wounds of those complex organs which are composed of bones, encrusted with a layer of cartilage, held together by ligaments, and having interposed between their cartilaginous surfaces a cavity lined on all sides by a highly organized synovial membrane.

Traumatic arthritis was rendered familiar to the earliest surgeons by the accidents of military life. The progress of knowledge has given us increased power of preventing its appearance, and of obviating its disastrous consequences, but it still remains one of the most alarming maladies to which our attention is directed. The synovial membranes, like the serous, to which they have a strong affinity, rapidly propagate the inflammation set up at a small point of their surface, so that the whole is soon involved. Nor is this all; the law of disease, by the operation of which tissues become affected by the lesions of contiguous structures, is no where more observable than in articulations. If the acute synovitis which frequently succeeds to a simple wound of a joint, be not checked, and a suppurative action be set up, the bone, ligament, and cartilage ere long participate, and the organ falls into hopeless disorganization.

Attempts have been made by writers on surgery to specify the classes of articulations most liable to wounds, and it has been generally agreed that the ginglymoid joints are more exposed than any other. It is no doubt true that joints of this class are less protected by soft parts than the enarthrodial, but there are other circumstances to be taken into consideration. The ginglymoid joints are more or less protected by bony processes, such as the olecranon and coronoid process in the elbow-joint, and the patella in the knee-joint, which are placed at the points most exposed to the penetration of foreign bodies, or least covered by muscle and tendon. The situation of a joint must also exercise an important influence. Thus in close combat, whether both parties be on foot or on horseback, the shoulder will be more exposed than any other articulation, and in charges made by cavalry or infantry, the knees of the former, and the shoulders of the latter will be chiefly liable to wounds. In point of fact, the records of military surgery show that wounds by cutting and piercing instruments are sustained by the shoulder more frequently than by any other joint. The liability to gunshot wounds is tolerably equal in all, since, in the large majority of cases, the force of projectiles is such as to overcome any resistance which soft parts can offer.

Writers on surgery, in treating of wounds of joints, have commonly founded the distinctions drawn between different wounds, on the various forms of the instruments producing them. There are certain advantages attending this arrangement, but it must not be forgotten, that precisely the same train of symptoms may, and frequently does follow wounds of very different form and extent. A more scientific and comprehensive classification may be made by a reference to the tissue or tissues involved in the wound, and the variations induced by the shape and size of the body inflicting the wound may be adequately noticed as varieties rather than as classes. Proceeding on this basis, the wounds of joints may be arranged under two general heads :—

1. *Simple wounds,*— comprising lesions of synovial membrane only.

2. *Complicated wounds;* including,—

a. Wounds complicated with injury of ligaments and cartilage.

b. Wounds complicated with injury of articular bone.

To these two complications a third important one might be added, in the shape of luxation, but this lesion will be considered with more propriety under the head of compound luxation. (See Luxation.)

1. *Simple wounds.*—The synovial membrane can never be the only articular tissue wounded in such joints as the shoulder and hip, which are completely enveloped by a capsular ligament, nor even in the ginglymoid articulations, unless the wound be inflicted by a narrow piercing instrument. The division of ligamentous fibre being, however attended with no active or immediate inflammation, may be passed over in silence while we are considering the phenomena developed by the injured synovial membrane.

The synovial membrane may be punctured by a piercing instrument, as a nail or the point of a bayonet,—may be freely divided, as by a knife or sabre,—may be penetrated with contusion, as by a shot and small bullets, or may be lacerated, as in compound dislocations. The only consequence, so far as the synovial membrane is concerned, to be apprehended from these different forms of injury, is inflammation, and the main difference between them arises from the greater or less proneness to this result. As a general rule, it may be laid down, that the degrees of exposure of the articular cavity and of serious consequences are in relation to one another; but it is a rule to which the case-book of every surgeon will present exceptions.

The diagnosis of simple wounds of the joints is sufficiently easy where the wound inflicted has widely exposed the articular cavity, but is of greater difficulty where a narrow piercing instrument has been employed. In this latter case we must form our opinion from the situation of the external opening, and its form and size compared with that of the instrument used, the course which the wound has taken, and the depth to which it is stated to have extended. In some cases, a flow of synovia from the puncture removes all doubts; but there is a source of fallacy connected with this symptom, which must not be lost sight of, since the synovia may have exuded from a bursa, or the wounded theca of a tendon. Nor must it be concluded, from the absence of a synovial flow, that the integrity of the joint is preserved, since the exit of the secretion may have been prevented by a change of the relation between the wound of the synovial capsule and that of the integuments, or by an effusion into the narrow canal formed by the passage of the instrument through the soft parts. Fortunately, an exact knowledge of the extent of the wound is not of sufficient importance to justify the introduction of a probe, which would indeed frequently afford no certain indication, while at all times it must produce irritation, expose to the danger that arises from the admission of air, and break up adhesions that may have already formed. The surgeon in these cases may borrow from politicians the principle of non-intervention. When the wound is extensive it may be readily recognized to have penetrated the joint by the flow, often copious, of synovia, which immediately takes place, and which may be readily reproduced, (though extreme gentleness ought always to be observed) by gently moving or pressing the articulation. At times all possibility of doubt will be removed by the exposure of the white and glistening surfaces of the articular cartilages.

After the infliction of a wound of the synovial membrane, it sometimes, and under wise management, not very rarely happens, especially if the wound be slight and air have not been admitted, that no alarming symptoms follow, and the parts divided heal rapidly by the first intention. This may even happen where the division has been very extensive. Thus Boyer[1] relates a case in which he saw the wrist joint completely laid open from its posterior surface; the ulna and radius projecting from the wound; the extensor tendons completely divided, and the hand pendulous by the soft parts situated anteriorly. He immediately reunited the edges of the wound, and at the end of fifteen days, it had completely healed. More commonly, however, where the patient is vascular and plethoric, where his constitution has been originally bad, or has been impaired by excess or disease; where injudicious scrutiny has been made of the wound; where absolute rest is not given to the limb, and even sometimes where none of these sources of evil are present, an acute inflammation commences. For twenty or thirty hours after the infliction of the wound, the patient seems comparatively easy and the accident appears trivial; but at the end of that period, there is felt in the joint a dull aching pain, which Begin[1] states to precede invariably according to his experience, all other symptoms. This pain, at first dull and intermitting, gradually increases in severity, till it becomes acute and constant, and is aggravated by the slightest motion; the articulation swells by effusion within its capsule; the surrounding cellular tissue becomes infiltrated, and the skin covering it is hence hot and shining, but not red; the lips of the wound are pale and thin, and throw out a purulent serum; œdema affects the limb below the injured joint, and an erythematous blush sometimes extends upwards towards the trunk[2]. The constitution now takes the alarm, and fever lights up: the respiration is hurried; the pulse hard; the tongue white, the surface hot and flushed; the countenance anxious; the thirst extreme: delirium sometimes supervenes; there is incessant watchfulness; subsultus comes on; and the patient, if of feeble habit, may be carried off in four or five days after the accident. Occasionally, the inflammatory symptoms are less severe, and are almost entirely local; but in general, the arthritis consequent upon a wound is of very acute character. The combined effect of the distension of the synovial capsule and of the surrounding infiltration, sometimes produces such pressure on the adjacent vessels that the limb below the injured joint falls into a state of gangrene.

This acute state of inflammation may have several terminations. Where the treatment is vigorous, and the previous health and habits of the patient have been good, the constitutional disturbance may subside with scarcely less rapidity than it supervened; the acute pain is mitigated; the swelling diminishes; and, with care, the limb is restored to its free and healthy action. In other cases, the febrile state passes off, and the local inflammation subsides, but does not altogether disappear; the joint continues slightly swollen; and a chronic synovitis is established, varying in its degree of intensity, but always imparting a certain debility to the limb, and liable to assume a more active form, or to induce disease of the adjacent tissues. The arthritis becomes chronic almost invariably in those who make premature use of the joint. During exercise the pain is scarcely perceived, but when rest is again given, a pricking pain, accompanied by a sense of weakness, is felt, and a moderate swelling displays itself where the structures around the joint are most distensible.

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[1] Traité des Maladies Chirurg.—Vide Plaies des Articulations.

[1] Dictionnaire de Médecine et Chirurgie Pratique. tom. iii. art. Arthrite Traumatique.

[2] Thomson states this to be a common symptom after gunshot wounds of joints. Vide Report of Observations made in British Military Hospitals in Belgium.

A third termination of acute arthritis occasionally, though rarely exemplified, is the effusion of a plastic false membrane, which contracts adhesions to the free synovial surfaces, and establishes a soft anchylosis more or less complete. The observations of several surgeons show that this is a possible result of active inflammation; but it would be incorrect to suppose it one of ordinary occurrence, since the synovial membranes, though allied in many respects to the serous, have a strong resemblance to the mucous, in their indisposition to form bands of adhesion. The reason may probably be the same in both, that the presence of the natural secretion prevents the effused lymph from becoming organized and adherent. In a fourth class of cases, the acute inflammation continues with unabated intensity, and a suppurative action is established. Here all the constitutional disturbance already noticed is displayed with extraordinary vehemence. There are severe rigors; the tongue becomes brown, dry, and harsh; the stomach rejects its contents; all the secretions are deranged; there is general mal-aise; great anxiety, or even marked delirium; the articulation becomes filled to distension with purulent matter, if the original wound has closed; and the tissues external to the joint rapidly take on an inflammatory action. The synovial membrane now ulcerates if there be no communication with the external wound, and the matter makes its way to the surface by long, winding sinuses. Even under this state of things the disease may be confined to the synovial membrane, and if the purulent matter have a sufficiently free exit, and the case proceed favourably, the suppuration will gradually diminish, the forces of the patient will rally, and he is ultimately restored to health with a joint but slightly stiffened. Thus Warner[1] relates a case of hydrops articuli, in which he made an opening into the joint, which was followed by suppuration. For the discharge of the pus the joint was opened a second and a third time, yet the patient, though placed in imminent danger, and very nearly sinking, ultimately recovered with little stiffness of the joint. The second case related by Hey, in his paper on wounds of the joints,[2] presents similar features (except that the wound was not inflicted by the surgeon), and had a similar termination. In other cases, granulations spring from the synovial membrane as the suppurative action diminishes, and the inosculation of these effects a cure by the establishment of soft ankylosis. These are the most favourable terminations of the formation of abscess in the synovial membrane, and our treatment ought ever to be influenced by the hope of obtaining them. More commonly, it happens that the disease is propagated to the other articular tissues, and a train of symptoms is developed precisely corresponding to those which are commonly witnessed in idiopathic disease, but more rapid in their progress. The cartilage in these cases is very early affected, and an ulceration commences on its free surface, which rapidly extends to the bone, and the osseous tissue having once become diseased, the mischief is perpetuated until amputation or death closes the scene.

Such being the symptoms, progress, and termination of wounds of the synovial membrane, it now remains to inquire what are the morbid appearances presented on an examination of the joints affected in the various stages depicted. The first effect of inflammation in a synovial membrane is probably, as in the mucous membranes, a cessation or diminution of the natural secretion. This is a condition, however, only inferred to exist, since we have very rarely the opportunity of examining joints at a sufficiently early period. To this succeeds a dense injection of the synovial surface accompanied with some tumefaction, and an increased secretion, which in some cases is sanguinolent. The folds or reduplications of synovial membrane which hang into the cavity of the joint, like valvulæ conniventes, partake in the general injection, and the cellular tissue and pellets of fat which they contain becoming infiltrated, they acquire an inordinate development, and overlap the cartilaginous surfaces in such a manner as to have been mistaken for a new membrane. If the inflammation be not subdued, red vessels begin to shoot over the membrane covering the cartilage, commencing always from the circumference, and often proceeding towards the centre in a regular march, and with a defined outline, which is to be ascribed with great probability to the limitation produced by the pressure of the opposing articular surface. In some cases, the surface of the synovial membrane now becomes covered with a layer of plastic adhesive matter from which villous and vascular prolongations depend into the articular cavity, and by the union of which with one another, and with the cartilaginous surfaces, a species of soft ankylosis is established. More usually, these villous prolongations are either absent altogether, or do not form adhesions; but the surface of the synovial membrane becomes dull, opaque, and traversed by brown or crimson patches, while its substance is thickened, and in some degree pulpy. If the inflammation pass into a chronic form, the joint continues slightly distended, with a serous or sero-albuminous fluid, and the synovial surface becomes granular, or even villous. If, on the other hand, a suppurative action be set up, the interior of the joint very commonly presents the appearance of an ordinary circumscribed abscess, and the joint becomes distended by purulent fluid, mixed with curdy or albuminous flakes, until at length ulceration occurs at different points in the synovial membrane, and the matter makes its way to the surface by fistulous tracks. Even under these circumstances, the lesion may still be confined to the synovial membranes, but in the immense majority of cases, the adjacent tissues share in the derangement. The ligaments become enlarged by a deposit of lymph in their articular tissue; lose their natural glistening appearance; and are gradually removed by ulceration. The cartilage is softened, and slightly tumid,—presents small fossæ on portions of its surface, extending to the bone; in other parts exhibits fibrous brush-like projections, which hang into the cavity of the joint, and, in the end, is entirely removed. This ulceration commonly commences at the circumference of the cartilage,—a phenomenon which is readily accounted for if the lesion be propagated as in many other cases by contiguity, since the portion of cartilage nearest to the inflamed synovial membrane must necessarily, in that case, be first affected. The bone becomes inflamed, and presents a softened highly vascular surface. In some cases, the inflammation is very much confined to the surface, and ends in the development of vascular granulations which ultimately prove the medium of ankylosis; but in other cases, the disease acquires a deeper seat and advances to a confirmed and obstinate caries. Occasionally, small spicula of bone are detached; and a cure may be effected by the removal, in this way, of the articular surfaces, but most commonly, amputation, or excision, are the only remedies.

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[1] Warner's Cases in Surgery.

[2] Hey's Practical Observations in Surgery. Ed. 3rd. Lond. 1814.

Around the joint are disposed masses of densely infiltrated cellular tissue, burrowing abscesses lined with granular lymph, and winding sinuses, the consequences of long-continued and deep-seated mischief. The morbid appearances of a wounded joint in the advanced stage of ulceration, correspond precisely to those produced by idiopathic disease. "Many of the phenomena," says Hennen, "presented by joints affected with white swelling are to be observed in some of the more protracted cases of gunshot injuries, and particularly a great diminution of their specific gravity."

The treatment of wounds of the synovial membrane will of course vary according to the period at which the surgeon is summoned after the infliction of the injury, and the varying phenomena which the progress of the case may present. The first indication after the reception of a wound is to procure immediate reunion. A meddlesome surgery is bad in these cases not less than in many others, and the surgeon ought not to be curious to ascertain the exact extent of the wound or the ease with which a probe can be passed into the articular cavity. If, however, there be a strong probability of the presence of a foreign body within the joint, a careful examination with the view of removing it is justifiable. In the majority of cases, however, this complication is not to be apprehended, and the wound may be treated as a simple incised wound, by the application of straps of adhesive plaster or of lint dipped in the blood flowing from the wound, and maintained in its position in the ordinary way. The next indication is to preserve perfect repose, and for this purpose it is advisable to apply a splint with bandages above and below the joint, as the patient, not at first suffering much from pain, almost unconsciously makes use of the limb. In addition to these means it is usual to employ warm or cold applications, but with more than doubtful utility, since the fluid must tend to prevent the close adhesion of the dressings, and can scarcely be otherwise than prejudicial to the raw surface of the wound. If the constitution of the patient be such as to threaten the access of inflammation, antiphlogistic measures may be adopted with the view of prevention. In all cases, the diet ought to be low, the skin to be kept open, and the bowels in good order, though not purged. No error is more common than that of administering drastic and irritating purgatives, even when there is no reason to suppose that the intestines are much loaded. Of course, there should be regular evacuations, but the necessity of frequently relieving the bowels creates an unavoidable motion of the joint, than which nothing can be more prejudicial to its restoration. If these simple measures be adopted, it not unfrequently happens that no alarming symptoms are developed, even when the articular cavity has been very widely exposed, and the patient is restored, without accident, to the perfect use of the limb. Sir Astley Cooper[1] relates cases in which compound dislocations of the ankle being thus treated were healed with extraordinary rapidity. Hey[2] relates the history of several wounds of joints in which the articulation was so exposed that he could pass his finger into it, which nevertheless recovered without accident; and Boyer[3], from whom we have already cited a similar narration, furnishes other examples.

"Many cases of wounds of the knee-joint," says Guthrie[4], "in which the capsular ligament is wounded, and the articulation opened without injury to the bones, do as well as simple incised wounds made with a clean-cutting instrument suddenly withdrawn after inflicting the wound." If, however, this desirable result should not follow, and inflammation commence, our measures ought to be taken early and with vigour. Blood-letting to a considerable amount ought to be made use of both generally and locally, the tartarized antimony should be administered in nauseating doses, or should be combined with calomel and opium, and every measure taken to moderate the fever that must ensue. As to diet, and the preservation of rest, precisely the same rules ought to be observed as before the accession of the inflammatory symptoms, but advantage will now be derived from the employment of a lotion around the joint, which may be used warm or cold according to the feelings of the patient himself. The common prejudice is in favour of cold applications, but I have seen very great advantages result from the combined effect of warmth and moisture. This treatment must be actively followed in proportion to the size of the joint involved, and the constitution of the person who has undergone the injury. If by these means the action should be reduced to a chronic form, the remedies commonly employed in chronic synovitis of idiopathic origin may then be employed. If, on the other hand, the acute inflammation should be followed by suppuration, our line of treatment must undergo a great alteration. The fear of forming an opening into the joint must now be abandoned, and as soon as the joint becomes distended with pus, if the original wound have closed or be of inconsiderable size, not allowing exit to the pent up fluid, a sufficiently free incision must be practised. Petit recommended that the opening should be of large size, while David, on the contrary, was in the habit of employing a trocar. Boyer thinks that both these modes are worthy of adoption in different circumstances; the latter, where the collection of pus has formed as a consequence of caries of the bone; the former, where the suppuration has been induced by a wound; and, as the object is to relieve the excessive pain and distension which the collection of matter occasions, Boyer's decision deserves our adoption. The relief which follows the free evacuation of the matter is very surprising, but the pus continues to be secreted, and the opening, therefore, ought to be made in as depending a position as possible, that the fluid may find vent almost as rapidly as it forms. The posture of the limb ought also to be regulated with a view to the attainment of this object, perfect rest being still enjoined. Emollient and anodyne poultices may be applied around the joint; the diet must be generous, and tonics or anodynes may be given as circumstances render necessary. It is impossible to sketch accurately the treatment that will be applicable to the various conditions of these alarming cases, and a brief outline is all that can be given.

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[1] Sir A. Cooper on Dislocations and Fractures.

[2] Practical Observations in Surgery. Edition 3rd. London, 1814.

[3] Traité des Maladies Chirurgicales.

[4] Guthrie on Gun-shot Wounds.

In the last described termination of this disease,—that in which the adjacent articular tissues become affected, the treatment adopted so precisely corresponds to that advisable when the lesion has been idiopathic, that it is unnecessary to enter upon its consideration. As a general rule, it may be laid down, with only too much truth, that in the present state of surgery, the most favourable terminations of this latter state to which we can look forward with any degree of confidence, are, in the lower extremities amputation; and in the upper excision.

2.—*Complicated wounds of joints.*—Of the complicated wounds, we have first to consider:—

a. Wounds complicated with injury of ligament and cartilage.

Lesions of this sort will demand very little of our attention, since the symptoms additional to those of wounds of the synovial membrane are not very numerous or striking. We know that in the enarthrodial articulations the synovial capsule cannot be opened without a corresponding wound of the ligamentous capsule. In other articulations, we form our opinion from the extent and size of the wound; the direction which it has taken, and the abnormal mobility which exists between the two articulating extremities. A wound of the cartilage can rarely be ascertained unless the joint be laid widely open, when the diagnosis is too obvious to require explanation. In either case, the immediate symptoms induced by wounds of these tissues, are so slight and immaterial, as commonly to be absorbed in the phenomena produced by the injured synovial membrane. If the divided ligament be funicular, the ends retract, and the interspace between them becomes filled up by newly-developed cellular tissue, which forms the bond of reunion, and ultimately acquires a ligamentous character. This process probably occupies some time, but in capsular ligaments, where the wound is made parallel with the fibres, the reunion, though still effected by cellular tissue, takes place very rapidly. Thus, after dislocation of the humerus, where the capsular ligament must be extensively ruptured, we often find the patient in the course of a week or two enjoying perfect motion of the arm. In unhealthy constitutions the reparative action now described is not set up, but the ligament becomes swollen by deposit in its reticular tissue, and ulceration ensues, attended by all the symptoms and appearances described in the former part of this paper.

Wounds of cartilage, though certainly unproductive of striking alterations, are not so barren of consequences as Lobstein, Velpeau, and Cruveilhier have represented. There is such a paucity of facts concerning the pathology of cartilage, that we have no right to assert the impossibility of an immediate reunion of divided cartilaginous surfaces. I incised the cartilage of the femur in the tibio-femoral articulation of a dog. The incision was so distinct, that I heard the cartilages "cry" under the bistoury, and the edge of the instrument grated on the bone. The dog was killed at the end of two days, and on examining the joint I was unable to discover any solution of continuity on the surface of the cartilage. The synovial membrane covering the cartilage was every where smooth and natural. Usually, however, it is found that for a considerable time, sometimes even weeks, after the division of articular cartilage, not the slightest reparative or morbid toil is exhibited. Subsequently, the divided surfaces are found rather widely separated; the sharp edges are rounded off, and a fine flocculent tissue of false membrane fills up the cavity made by the incision. There are no facts on record to show that this false membrane ultimately becomes converted into cartilage, but Beclard asserts, very positively, that this tissue may be reproduced[1]; and the frequency with which cartilage is found among the adventitious analogue deposits may incline us to adopt his opinion. Where, in disarticulations, the cartilage is purposely scored or scraped, the flaps adhering to the cartilaginous surfaces of the stump heal by the first intention, but if suppuration comes on, the cartilage ulcerates and gradually becomes detached in flakes. It is extremely probable that another consequence of the wounds of cartilage may be ulceration, almost the only form in which chondritis displays itself. After an arthritis following a severe wound of the knee-joint, in which the patella had been completely divided by a bill-hook, and the cartilage of the femur wounded, I saw the cartilage of these two bones extensively destroyed and worm-eaten, by ulceration; but in this, and in all other similar cases, it must remain for the present an undetermined question, whether the ulceration is the effect of a morbid action induced in the cartilage by the wound, or whether it is owing, as in ordinary disease, to the propagation of inflammation from the synovial membrane.

The treatment of complicated wounds of joints of this class, must be in the first instance precisely similar to that already described as applicable to simple wounds. Where the cartilage is affected, it will be right to watch over the patient with increased care,—to enjoin upon him perfect rest for a longer time, and to treat with greater vigour any indications of debility and disease which the articulation may offer. When the ligaments have been divided, a very nice point will test the judgment and pathological knowledge of the surgeon. If too early motion be given, the intervening cellular tissue, which forms the bond of union between the divided ends of the ligament, will admit of great distension,—the ligament will in consequence pass into the condition termed diastasis, or, in other words, become relaxed, and the articulation will become weak, unstable, and constantly liable to sprain or luxation. It is by a knowledge of this fact, that Dr. Stromeyer has been successful in treating varus. The wounds of a fibro-cartilaginous structure, such as the tendo Achilles, heal like those of ligament. Availing himself of this fact, Stromeyer, in those cases of varus which depend on extreme contraction of the gastrocnemii muscles, has divided the tendo Achilles, and, by communicating motion to it at a very early period after the establishment of reunion, has succeeded in increasing the length of the tendon to such an extent that the patient has been restored to the natural use of the foot. If, on the other hand, the joint remain too long motionless, the ligament becomes stiff and unyielding, and long treatment is required to restore the proper flexibility. No certain rule can be laid down to guide the practitioner into the safe and middle path between these two evils; since differences of constitution, and the uncertain extents to which the divided ends of the ligament may be separated, occasion frequent variations. The best guide is to be found in the feelings of the patient. If, on permitting a little gentle exercise, the joint be found weak and unstable, perfect rest must be enjoined for some time longer. In all cases, the application of a bandage, or of a casing of adhesive strapping will be found advantageous, when the joint is about to be again exercised after division of one of its ligaments.

b. *Wounds of joints complicated with injury to articular bone.*—Wounds of joints, with this complication, are usually very severe; and although the assistance of the surgeon may frequently, and even generally be available to the preservation of life, the integrity of the limb can rarely be preserved. The large majority of these wounds are produced by projectiles, but there is no form of instrument which may not also produce them if great force be applied. I have seen the patella completely divided by a bill-hook; and in another case, the cancelli of the humerus laid bare, the elbow-joints widely exposed, the inner condyle broken off, and the cartilage torn away in flakes by the friction of a cart-wheel. The diagnosis of these wounds is in general easy, since the accompanying destruction of soft parts will usually admit of our examining the joint by the eye, or by the touch. The most difficult cases are those in which a ball, having entered by a narrow opening, has been turned aside from its direct course by meeting with the bone, and, having splintered the head of the bone, and lacerated the synovial capsule, has become imbedded. It would intrench on the province of others, to enter at large into the consideration of this and some corresponding phenomena, which will be treated of under the head of GUNSHOT-WOUNDS. For the same reason, the reader is referred for the symptoms, progress, termination, and morbid appearances of the WOUNDS OF BONE, to the article under that head. The present paper is devoted, not to the description of these complications themselves, but of the effect which they produce upon the progress and treatment of a wounded joint. The remarks therefore on every feature of these wounds, except the treatment, will be exceedingly brief.

The progress of these cases may be divided into three stages. The injury, as we have already mentioned, is usually very severe, and the shock to the constitution consequently great. During the six, eight, or twelve first hours after the accident, the patient is either in a state of depression, or is so calm and tranquil, that an actual examination alone convinces the surgeon of the extent of the mischief. The exposed surfaces of bone and soft parts seem at this time to be benumbed, so that no pain is complained of, even on rough handling. The second stage commences by the ordinary symptoms of fever, thirst, restlessness, a hot skin, a full and accelerated pulse. The fever rapidly advances to a formidable height, the wound becomes exquisitely painful, and the progress of the case during this stage very much resembles that of a simple wound, as already depicted. In the third stage severe inflammatory symptoms have died away, but have left the patient feeble, and exhausted with a large suppurating wound—the cartilage ulcerating, the bone carious, and hectic commencing. This is the outline of ordinary cases, but extraordinary cases occasionally occur in which an admirably balanced constitution prevents the development of any alarming symptoms, and the injury inflicted is repaired with very trifling disturbance.

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[1] Beclard says, that in diarthrodial articulations the destruction of the cartilages is sometimes followed by their regeneration very nearly perfect, but the new cartilage, being thin, has a violet colour from its semi-transparency.—*Anatomie Générale.*

A favourable termination is not very common when the joint is left to itself, and constitutional treatment only adopted. The patient very often does not survive the second stage, but is destroyed by the intense fever which is then developed. Should this not happen, he usually lingers through a period of weeks, or even months, but at last dies exhausted by an incessant suppuration, which is maintained by diseased bone and ulcerating cartilages. There is, indeed, not an inconsiderable number of cases on record, in which this third stage has ended more happily. Thus Hunter[1] relates a case in which a ball entered the knee-joint at the outer side of the patella, traversed the knee-joint, and came out through the external condyle. Light dressings only were applied, and though severe inflammation came on, the patient recovered. Larrey[2], in his second Spanish campaign, tells of a Mameluke who received, besides other injuries, a sabre-cut in the left arm, which divided the skin, the olecranon, an articular portion of the humerus, the corresponding ligaments, and some branches of recurrent arteries. The wound was lightly dressed, and although some "grave accidents" were developed in the progress of the case, the patient recovered, and preserved some of the mobility of the joint. Sir A. Cooper[3] relates two cases in which persons recovered from compound fractures of the patella, followed by suppuration of the joint; and in the same work, Mr. Travers reports an example of compound fracture of the articular extremity of the femur extending into the knee-joint, from which, although the external condyle, with part of its articular surface, sloughed away, the patient recovered with a free use of the joint. These cases, however, form the exception, not the rule; and he who believes in the pithy axiom of Dionis, 'It is better to live with three limbs than to die with four,' will not allow them to guide his general practice. If he did, he would find, to use the phrase of Dupuytren, that he lost more lives than he saved limbs. The morbid appearances presented by wounded joints of the class now under consideration, are, with the addition of the injury to the bone, precisely similar to those already described under the head of simple wounds. In an advanced stage, the resemblance to the conditions produced by idiopathic disease is very striking. "In the dissection," says professor Thomson[1], "of many of the knee-joints after amputation, I found that the balls, in passing through the joints, had fractured the ends of the bones, and had occasioned, in the synovial membranes and cartilages, appearances very similar to those which occur in scrofulous affections of the joints. The cartilages were loosened in some instances from the bones, in others they were partially absorbed, and in the divisions of the cartilage produced by fracture, the edges were rounded off by absorption: the synovial membrane was much thickened in substance, and covered by soft, velvet-like, spongy granulations."

There are three methods of treatment which are applicable to wounds of joints complicated with injury to bone.

1. The case may be treated as a simple wound of a joint. This method is most applicable when the patient is young, when the joint is of comparatively small size, when the injury to the bone consists in a clean division, by a sharp instrument, or in a simple fracture, and when the soft parts are not extensively injured. In no case ought it to be adopted where the bone is so much injured as to forbid all hopes of its again forming part of an articular cavity, where surrounding soft parts are so contused as to render their sloughing away extensively, certain, where the previous health and habits of the patient have been bad, or where he cannot be placed under the circumstances of regimen and control favourable to a successful issue of the severe struggle that must ensue between nature and the disease. If, however, the patient be young, and of a sound, well-balanced constitution, if the circumstances be favourable, and the wound such as has been described, it is fair to try what can be done towards preserving the limb in all its integrity. The method of treatment pointed out as applicable to simple wounds of joints should be vigorously prosecuted; and the writings of Hey, Cooper, Larrey, and Guthrie furnish reasons sufficient for entertaining hopes of a favourable termination of such cases. Too great circumspection, however, cannot be shown in deciding on this course; for there is scarcely a

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[1] Hunter on the Blood, Inflammation, and Gunshot-wounds.

[2] Mémoires de Campagnes et Chirurgie Militaire, tom. iii.

[3] Cooper and Travers's Surgical Essays, part ii.

[1] Thomson's Report of Observations made in the British military hospitals in Belgium. Edinburgh, 1816.

more formidable train of symptoms than that presented in acute traumatic arthritis, and it too often happens when twenty or thirty hours have been suffered to pass away after the accident, without excision or amputation, that an opportunity has been lost which can never be restored. "Let us suppose," says Dupuytren[1], "one of the large articulations surrounded with muscles, tendons, and aponeurotic membranes filled with spicula, inflamed, suppurating, full of pus, and we shall have an idea of the gravity of the wound." It ought ever to be remembered, that life is the sacred deposit which is entrusted to our keeping, and that the churchyard often contains unanswerable arguments against the rules deduced from a few glittering cases.

2. The articulating extremities of the wounded joint may be excised, and the case treated subsequently as a compound fracture. Whatever may be thought of the excision of joints, idiopathically diseased, the general consent of surgeons has established the propriety of the measure when the lesion of the joint is traumatic; and the weight of testimony in its favour seems unanswerable. In 1814, Baron Percy informed Mr. Crampton, that by excising the articular extremities, he had repeatedly succeeded in saving limbs which otherwise must have been amputated[2]. In the campaign of Egypt, Larrey[3] ten times excised the head of the humerus, in cases in which he would otherwise have amputated at the shoulder-joint, and nearly all the patients recovered. In one remarkable case, he removed, with perfect success, the head of the humerus, the acromion process, the acromial extremity of the clavicle, the glenoid cavity, and part of the spine of the scapula. Sir Astley Cooper[4] records an immense number of cases of compound dislocation of the ankle-joint, in which the articulating extremity of the tibia was sawn off, and the results of the practice are contained in the following remarkable declaration:—"I have known no case of death when the extremities have been sawn off; although I shall have occasion to mention some in which the cases terminated fatally when this has not been done." The testimony of Hey, Taylor, Parke, Wachter, Balguer, and Guthrie, might be also quoted as to the efficacy of this measure. "As to the great articulations," says Dupuytren[5], "if the lesions are not extensive, and are confined to a single bone, we may substitute the resection of the injured bone for amputation."

The main advantage presented by excision is the preservation of the limb in a certain state of efficiency. The injured bone is removed, and a clean incised surface substituted for it; the cartilage, of which the ulceration can scarcely be prevented, is also removed, and much of the highly organized synovial membrane shares the same fate. The spasmodic contractions of the muscles, often productive of great mischief, and always of great distress, are prevented by the shortening of the limb which ensues, and the consequent relaxation of muscular fibre; no sharp osseous spicula are left to create and maintain irritation; adhesion between the sawn surface of one bone, and the cartilaginous surface of the other, is more readily affected; and the pabulum, so to speak, of high inflammatory action being removed, the constitutional suffering is greatly diminished. "The constitutional irritation," says Sir Astley Cooper[1], when speaking of excision in compound dislocation of the ankle-joint, "is very much lessened, both by the suppurative and ulcerative process being diminished, and the ease with which the parts are restored. In the cases which I have had an opportunity of seeing, there was not more irritative fever than in the mildest cases of compound fracture." After excision, ankylosis, sometimes osseous, but more commonly ligamentous, ensues. Larrey noticed, that when union took place by the first intention the bones became consolidated. Usually the bones are united to one another by ligamentous fibres of varying length and flexibility, but always admitting of a certain degree of motion, and the injured limb often acquires great strength and dexterity.

The circumstances under which excision is applicable remain to be stated. It may be practised immediately after the accident when the lesion is confined to the head of the bone. If the epiphysis be splintered, or a portion broken off, and the joint widely exposed, the most alarming result may be anticipated, if excision be not employed. If the body of the bone be much injured, and long fissures extend from the epiphysis downwards; or if the soft parts be so much lacerated and contused as to forbid the hope that the vitality of the limb can be preserved, excision will be contra-indicated. It may also be laid down as a general rule, that the excision of the joints of the lower extremities is unadvisable, while in the upper extremities its utility is very great. The causes of these differences are obvious. "Art may provide a clumsy substitute for the inferior extremities; but no ingenuity has hitherto succeeded in supplying the deficiency of that wondrous organ, the human hand. It is also evident from the purposes to which the inferior limbs are destined, that to be useful at all, each must possess a degree of strength corresponding to that of the opposite side. The two lower limbs constitute a single organ: they must unite to perform the functions for which they are designed; and one limb is of little use without the other, or a substitute of equivalent strength. The upper extremities, on the contrary, are two perfectly distinct and independent organs, capable of being combined to effect a given purpose, but equally capable of acting separately. Hence an inequality of length, power, and mobility in the upper extremities produces little inconvenience, compared with that arising from a similar state of things in the lower. The injured arm will be extensively useful as an assistant to the other, and will be adequate to the performance of many little offices; while the uninjured arm may be reserved for those occasions which require great strength and freedom of motion[1]." To this it may be added, that the large size of the articulations of the lower extremity renders the operation more dangerous, as a greater wound is inflicted. Where, however, the head of the femur is shattered by a ball, excision is unquestionably preferable, if other circumstances be favourable, to amputation at the hip-joint; and the success which has attended resection of the tibia, in injuries to the ankle-joint, furnishes ample warrant for applying the treatment to that articulation. There can be no doubt that in the upper extremity, excision is at least not more dangerous than amputations, and it ought therefore to be practised where any hope can be entertained of preserving the limb[2].

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[1] Leçons Orales de Clinique Chirurg. Paris, 1832, tom. ii.

[2] Dublin Hospital Reports, vol. iv.

[3] Mém. de Chirurg. Militaire, tom. iii.

[4] Sir A. Cooper on Dislocations and Fractures.

[5] Leçons Orales, tom. ii.

[1] Cooper and Travers's Surgical Essays, part ii.

3. The third measure which the surgeon may be called upon to adopt in treating wounds of joints complicated with injury to bone is amputation. Though always a painful resource, and never to be adopted until life and limb are laid in the balance against each other, it is often imperatively necessary. Attempts have been made to define accurately the cases in which amputation ought to be practised, but they have been signal failures, and such attempts will continue to be so until our knowledge of diathesis is much more extended. An injury the most severe and extensive will produce no alarming symptoms in one case, while in another the slightest and most trivial accident will rapidly develope fatal consequences. The constitution of the patient must therefore receive careful attention, not less than the character of the wound; and regard must also be given to the situation of the patient, as favourable or unfavourable to recovery. Modes of practice which would be wholly inadmissible in domestic surgery may often be expedient amid the hurry and confusion of a camp. When the constitution of the patient is bad, and his age advanced; when careful attention cannot be given to him, when he is placed in a crowded and unhealthy hospital, when the lesion is not confined to the articular apparatus, but extends into the body of the bone, when the soft parts are much lacerated or destroyed, when, to the injury of the joint, is added the rupture of a large blood-vessel, recourse must be had to amputation. When the knee-joint is extensively injured, there ought rarely to be any hesitation in amputating, since even if excision were performed, and the patient survived the long and tedious process by which the enormous wound must be healed, the superiority of the preserved limb to an artificial one would, in the majority of cases, be very questionable. In other joints, if excision furnish a reasonable hope, it ought to be practised, but when we dare not excise, we must amputate.

The only point remaining for consideration is the time at which amputation or excision, if deemed absolutely necessary, ought to be practised. Three stages have been described through which patients pass after wounds of joints attended with injury of bone. During the second of these, or the stage of acute inflammation, by the general consent of surgeons, amputation has been forbidden; but there has been a great question whether the operation be most advantageous in the first or third stage. English surgeons, with the exception of John Hunter, have long advocated the first stage, and the Continental surgeons of to-day are adopting the same opinion, though many of their predecessors opposed it, and the Academy of Surgery gave its sanction to the opposition. When the amputation is performed in the first stage, that is, within twenty or thirty hours after the accident, it is called immediate; when in the third stage, or after the lapse of several weeks, secondary. Among the advocates of secondary amputation, may be mentioned Faure, who gained the prize offered for the best essay on this subject by the Académie de Chirurgie, in 1756[1], John Hunter, whose experience, however, was not very extensive, and Lombard, professor of surgery in the Military Academy at Strasbourg. On the opposite side are found Wiseman, Le Dran, Boucher, Ranby, Larrey, Hennen, Copland Hutchinson, Guthrie, Dupuytren, and Velpeau. It is urged by the former party, that if the patient cannot withstand the inflammation developed by the wound, neither can he sustain the shock of amputation; that the amputation is a violence superadded to the injury, and therefore heightens the danger; that many of those amputations which are performed on the field of battle terminate fatally. Faure quotes ten cases which, after the battle of Fontenoy, were reserved for secondary amputations, and all of which were successful. To these arguments it may be replied, that by amputating immediately, the character of the wound is changed; that, instead of a ragged, lacerated wound, with sharp spicula of bone and an open cavity prone to active inflammation, we have a simple incised surface, smooth bone, and no danger of synovial inflammation; that if patients were reserved for secondary amputation, a large proportion would perish in the stage of active inflammation; that the fatality of amputations performed on the field of battle, even if admitted, may be readily accounted for by the extreme severity of many of the wounds, which renders the operation from the first all but hopeless, and by the want of proper attention subsequently. Dr. White, a naval surgeon, who practised in 1703-4, upon the coast of Portugal, writes, "when amputations are requisite they succeed ten to one better where the operation is performed immediately after the misfortune, than four or five days after. This all our surgeons in the army very well know, as well as in the navy[1]." "The primary amputation," says Dupuytren[2], "will find the patient full of resignation, power, and courage: the secondary amputation will find him broken down, discouraged, exhausted, or armed with a resolution which will be fatal to him." But independently of all other reasoning, experience, our surest guide, is sufficient to decide the question. "During the peninsular war," says Guthrie[3], "the success of amputations performed on the field of battle became so notorious, even among the soldiery, that the anxiety expressed by them to have these operations performed with as little delay as possible was frequently prejudicial."

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[1] Blackburn on the Excision of Diseased Joints.—Guy's Hospital Reports, vol. i.

[2] For a fuller consideration of the value of excision, and for directions as to the treatment to be pursued after excision, the reader may consult the article Resection.

[1] Faure's memoir may be found in the Prix de l'Académie de Chirurgie, tom. iii. 12mo. Paris.

After the battle of Toulouse, forty-seven primary amputations were performed, of which thirty-eight were successful, and fifty-one secondary, of which only thirty proved fortunate. Of the primary amputations at the shoulder-joint performed after the battles of Vittoria, Pampeluna, and the Pyrenees, and the siege of St. Sebastian, the successful cases were as sixteen to one, while, out of nineteen secondary operations, performed in the general hospital, fifteen terminated in death.

Baron Percy, after the battle of Newborough, performed ninety-two primary amputations, of which eighty-six were unsuccessful[4]. Of sixty operated on immediately after the sea-fight of January 1, 1794, eight only died. After the battle of Aboukir, eleven soldiers were operated on immediately, all of whom recovered, and there were three consecutive amputations, all of which proved fatal. At the battle of Navarino, M. Del Seguore, surgeon to the Egyptian army, performed thirty-one immediate amputations, all of which were fortunate, and thirty-eight secondary, of which twenty-five were successful. After the three days of July, about a hundred amputations, primary and secondary, were practised, and the results were very decidedly in favour of the immediate performance of the operation[5].

These facts appear to be very decisive, and it will be readily admitted that, if any, the wounds of joints imperatively require immediate amputation, since the inflammation which follows them is much more formidable than that which follows the wound of any other part of a limb, and the hopes of restoration are much less. Mr. Guthrie very judiciously notices, that even in primary amputation, sufficient time ought to be given to allow of the recovery from the collapse which immediately succeeds the injury; and Roy, who was chief surgeon to the French army of the Rhine, in 1794, coincides in the opinion. Guthrie states, that he has seen more than one patient die upon the table when the operation succeeded the first shock, almost immediately. The best time for the operation is unquestionably that brief period which intervenes between the subsidence of the collapse, and the supervention of the first signs of inflammation. (For BIBLIOGRAPHY, vide the article ARTICULATIONS.)

(*John Blackburn.*)

ARTICULATIONS, *ἄρθρον*, Gr.; *articulus, arthrosis, junctura*, Lat.; *articulation*, Fr.; *Articulation*, or *Gelenk*, Ger.; *articolo*, Ital.

An articulation is the junction of two or more bones or parts performing the functions of bone. This is the only strict and logical definition which can be given of the term, unless we are to exclude from among articulations the varieties of synarthrosis called schindylesis and harmonia. In a more lax sense, the word may be understood to mean the junction of bones, or parts performing the functions of bones, by the intervention of a third structure or class of structures, so disposed as to admit of motion.

It would be remote from the object of the present article to enter into anatomical details, either general or descriptive[1], farther than is absolutely necessary to illustrate and defend the pathological views which will be advanced. The common anatomical division of articulations, which is grounded partly on form, partly on structure, and partly on mobility, may therefore be passed over in silence. For the purposes of the surgeon, a more convenient classification may be instituted on the basis of structure only. Viewed from this point, the articulations of the human frame will be found to resolve themselves into three classes. In the first class, of which the facial sutures furnish the chief example, surfaces of bone are simply adapted to each other, without the intervention or assistance of any other structure than the periosteal covering. In the second class, of which the type is found in the junctions of the vertebral bodies, the bones entering into the articulation are united through the medium of a third structure,—sometimes cartilaginous, as in the cranial sutures, but more commonly fibro-cartilaginous, as in the pelvic symphises,—which is interposed between them, and firmly united to the surface of each. Articulations of this class are in general strengthened by the addition of circumferential ligaments. In the third, or highest order, to which belong the joints of the extremities, the surfaces of the bones are covered with cartilage, and play upon one another; the connection is maintained by ligaments, disposed in various forms, and the motion is facilitated by the viscid secretion of a synovial membrane. Into several complex articulations of this class, there also enters fibro-cartilaginous tissue, sometimes disposed in the form of an intermediate layer between two surfaces of bone, but having no attachment to either, as in the inferior maxillary, sterno-clavicular and knee-joints,—at other times arranged around the margin of an articular cavity, forming what Meckel terms fibro-cartilages of circumference, as in the hip-joint.

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[1] White, De Rectâ Sanguinis Emissione. London, 1712.

[2] Leçons Orales, tom. ii.

[3] Guthrie on Gunshot Wounds.

[4] Velpeau, Médecine Opératoire.

[5] Op. Cit.

[1] Meckel's admirable treatise will furnish adequate information, both on general and special anatomy; or on the former subject, the reader may refer with great advantage to Dr. Todd's excellent article, "ARTICULATIONS," in the Cyclopædia of Anatomy and Physiology.

It is obvious that these different classes, ascending from the most simple form, in which a junction can be effected, to one very complex and intricate, will present striking differences in their proneness to morbid actions; and it will be found that this proneness is in close relation to the degree of complexity. In the simplest form of which bone is the only constituent, we meet with no articular disease, unless indeed we are to style as a disease their separation, which is described by Jourdain in the Dictionnaire des Sciences Médicales. The known diseases of the second class, though important and highly interesting, are comparatively few in number. The morbid states of the third class are very numerous, frequent in their occurrence, and often most disastrous in their consequences.

The lesions, of which joints are susceptible, arrange themselves naturally in two divisions, according as they arise from external or internal causes. The lesions belonging to the former of these divisions are three in number.

1. *Wounds.*—The wound of a joint consists essentially in an opening being made into the synovial capsule. This opening may be a simple penetration of the capsule by the point of a nail, or it may be the widest exposure of the articular cavity, attended with disruption of ligaments, and splintering of the head of a bone. In either case, the most energetic treatment is demanded on the part of the surgeon to prevent the fatal effects that frequently ensue.

2. *Sprains.*—A sprain consists in the violent distention or actual rupture of ligamentous fibres, without displacement of articular surfaces. It is the consequence of a strong effort to extend the motions of a joint beyond the limits which nature has assigned. It is not often produced by muscular action, or by force applied in a direction parallel to that of the ligamentous fibres. More commonly, it arises from the weight of the body being brought to bear on the ligaments obliquely. Hence it occurs most frequently in the ankle-joint, or in the wrist after a fall upon the hands. It has been customary to include, under the head of sprains, the morbid condition, termed diastasis, or relaxation of ligaments; but, as this condition arises from internal causes rather than from injury, it will be classed with more propriety among the idiopathic diseases of ligamentous tissue.

3. *Luxation.*—The application of force under certain circumstances may determine a change in the natural relations of the articular surfaces; either partial, as when the head of the humerus rests on the brim of the glenoid cavity,—or complete, as when the head of the femur is carried into the foramen ovale. This state of things occurs, most commonly, in joints of the third order, and, as a general rule, is found to be more or less frequent in them, according to the degree of mobility which they enjoy, the rationale of which is sufficiently obvious. When complete luxation is attended with laceration of the ligaments and synovial capsule, and with violent stretching or even rupture of the muscles inserted into the head of the luxated bone, when uncomplicated and recent, it is a lesion over which surgical skill has great control. Sometimes, however, it is complicated with a wound of the joint, in which case it is termed compound dislocation, and constitutes one of the most formidable accidents to which the human frame is liable. In articulations of the second order, luxation is not a very common occurrence, and is usually accompanied by fracture. Dislocations of the cervical vertebræ sometimes, however, occur without any such complication. Occasionally luxation is a consequence of disease in the articulation, but in this case the phenomena presented differ widely from those produced by external agency. The task of classifying the lesions of joints arising from external injury is not more easy than that of classifying their idiopathic diseases is difficult. Until of late years, no sound or correct basis of classification has been adopted. Symptoms were elevated into diseases, and diseases the most various were blended under one comprehensive title, until the whole subject became involved in inextricable confusion. The broad stream of light which morbid anatomy, aided by general anatomy, has thrown upon disease, has removed some of these evils, and every surgeon must feel gratification in paying a tribute of warm admiration to the merits of Sir Benjamin Brodie, by whose admirable researches the pathology of articulations may be said to have been created. Previously to the publication in the Medico-Chirurgical Transactions of the papers which formed the basis of Sir Benjamin's well-known and most valuable work on the diseases of joints, it was customary to rank all the serious maladies to which articulations are liable, under the convenient but unhappy term of white swelling. Thus Benjamin Bell treats of diseases of joints under the following heads:—1. Collections within the capsular ligaments. 2. Concretions and excrescences, within the capsular ligaments. 3. White swelling. Mr. S. Cooper makes a similar division, but adds a treatise

on arthritis. Boyer, the most minute and laborious of systematic writers, speaks only of foreign bodies, hydrops articuli, white or fungous swellings of joints, and ankylosis; and the classifications adopted by Delpech and other eminent surgeons are equally vague and indiscriminate. Even within the last few years, Mr. Liston, the author of a systematic work on surgery, has taught that it is a waste of time to attempt to distinguish between primary diseases of cartilage and of synovial membrane. "Such knowledge," he says, "is of no practical utility." That much yet remains to be done is indisputable, but we have the satisfaction of knowing that a great advance has been made, and of appreciating some of the deficiencies which still exist. I proceed to indicate the basis on which the division adopted in the present work will rest.

A correct and useful classification of the diseases to which any organ is liable, can be founded solely on a careful connection of the symptoms observed during life, and the order of their occurrence, with the appearances revealed to us by post-mortem examination. A perfect pathology would not only point out the structure in which disease had commenced, but would also determine the exact nature of the process which had been instituted. Hitherto pathologists have mainly directed their efforts towards the accomplishment of the former of these two objects, and rapid advances have been made in the localization of disease, while but little has been done in the way of investigating the various processes by which changes have been induced. There can be little doubt that under the broad term inflammation, which is applied indiscriminately to every organ, and almost to every abnormal state, we are including, not merely those modifications of morbid action which arise from structural peculiarity, but also various separate and distinct diseases. An illustration of these remarks may be found in the pathology of chest affections. The day has not long gone by, when the diseases of every structure connected with respiration were classed under the general head of inflammation of the lungs. We have now advanced, by the aid of a localizing pathology, to the recognition of pleuritic, pneumonic, and bronchitic inflammations. Other advances in the same direction may be made, by determining the exact tissue which becomes first affected in these several structures: but when this is done, there will still remain the questions, Is inflammation the sole disease? Is a pleuritis, which leaves behind it a clear serous fluid, or a muddy collection of pus, the same disease with a pleuritis which deposits a semi-solid, highly organizable lymph, rapidly becoming attached to the adjacent parts, and forming a fine web of cellular adhesions? Is a bronchitis, which is attended with the expectoration of a fibrinous tissue, taking the form of the bronchial ramifications, the same disease with a bronchitis which gives rise to purulent sputa scarcely distinguishable from pus? Is a pneumonia which leaves the lung thoroughly and permanently consolidated by a plastic lymph which becomes a part of the frame, in truth the same disease with a pneumonia which pours into the pulmonary tissue masses of a white, inorganizable product, rapidly softening down, and forming large purulent collections? These are questions to which subsequent researches may furnish more satisfactory answers than can now be given. It may be safely affirmed, that at present, with the slight and obvious exceptions of external injuries, and heterologue deposits, we know of few abnormal states which are not referred, directly or remotely, to inflammation. Even syphilis, gonorrhœa, and struma, are only specific inflammations. Attempts have indeed been made to introduce a process termed irritation, as something distinct from inflammation, but the medical world is so completely divided as to the meaning which is to be attached to the word, that for all practical purposes it is as yet unavailable.

There being therefore no satisfactory distinction between the processes by which morbid actions are carried on, the only sure basis which, in the present state of our knowledge, can be assumed in attempting to classify the diseases of articulations, is that furnished by the localizing pathology to which I have already alluded—the basis of tissue. Every living tissue is susceptible of morbid changes. Hence, in classifying the diseases of an organ, our first inquiry must be, into the tissues—whether common or peculiar—of which it is composed. I have already specified the tissues which enter into the composition of joints to be bone, fibro-cartilage, ligament, synovial membrane and cartilage, and I now proceed to point out the diseases of which each of these tissues is the primary seat, and to show how, in this manner, all the idiopathic diseases of articulations may be rationally comprehended.

1. *Bone.*—The portions of bone entering into the composition of a joint, consist of a mass of reticulated structure, endowed with a higher degree of organization than the shaft of the organ, and covered on the articular surface by a delicate layer of dense bone, to which the cartilage or fibro-cartilage is firmly attached. In this situation the bone is generally expanded, so as to form a protuberance, readily perceptible beneath the integuments; and the exposure to the influence of external causes which thence arises, combines with the high organization of the tissue to make disease a frequent occurrence. We find in it exemplifications of all the diseases to which bone is liable. Sometimes it becomes the subject of necrosis. This is not a very common occurrence, but I have seen a case in which a partial necrosis having taken place, one extremity of the dead bone protruded into the cavity of the articulation through an opening formed in the articular surface. More frequently it is the subject of inflammation, ending either in the formation of abscess within

the head of the bone, and indicated by a train of most alarming symptoms, to which Sir B. Brodie has called the attention of the profession, or assuming a chronic form, and slowly advancing to the state of confirmed caries. Beclard says that by this cause a separation of the shaft from the epiphyses is sometimes produced in young subjects, and the observations of Pott and Bromfield confirm the assertion. By far the most frequent disease, however, to which the articular extremities of bones are liable, is the inflammation and caries which depend upon scrofula, and which may not unreasonably be supposed to be connected with a deposit of tubercular matter in the cancelli of the bone. "Scrofulous diseases of joints," says Pott, "often commence in the very inmost recesses of the cellular texture of the heads of bones. In examining a joint in the early stage of this affection, we discover no trace of morbid change in the ligaments, cartilage, or synovial membrane, but on making a section of the bone it is found to present none of the cellular cavities proper to its normal state; and the striæ of bone which ought to be seen traversing its structure are indiscernible. An unbroken or granular surface is presented of a pale yellow colour, and the structure of the bone is softer than natural. At a more advanced period of the disease, this structure begins to soften down and ulcerate, the ligaments lose their connection with the bone, in consequence of the spread of the ulcerative process, the synovial membrane takes on a chronic inflammatory action, and the cartilage begins to be detached. At a still later period, abscesses form in and around the joint, which opens externally by long fistulous tracks; no trace remains of the ligamentous tissue; the synovial membrane has become so altered in character, that its peculiar features are no longer discernible; the greater portion of the cartilage is removed; the head of the bone is deeply excavated by ulceration, and so soft that it may be divided with a knife. The appearance of the remaining cartilage in this state of things is so peculiar, that it may almost be regarded as diagnostic of the disease. The removal of the cartilage commences on its attached surface, and it is not uncommon to see a flake of cartilage supported by its continuity with other portions of cartilage, over-hanging the diseased and excavated bone. On taking hold of a portion of this tissue it may be easily detached in flakes of considerable size from the bone beneath, which is dark, ulcerating, and denuded. In the cases of ordinary inflammation, such as are cited by Key, Mayo, and Gerdy, either granulations, by which the removal of the cartilage is supposed to be effected, are thrown out from the osseous surface, or the cellular membrane interposed between the cartilage and the bone, invisible in the healthy state, becomes highly developed and vascular; but in scrofulous caries the bone seems altogether incapable of this action, and presents, as already mentioned, a dark and denuded surface. A large proportion of the cases formerly termed white swelling, were undoubtedly of this class, as may be readily seen by referring to the excellent practical work of Crowther; and from the similarity of the attendant symptoms, it is not unfair to presume that the pathology of the morbus coxarius in young subjects is not widely different. Under the head, therefore, of articular osteitis, comprehending, in addition to the ordinary form of inflammation, that also which rapidly induces the death of the tissue and that peculiar lesion, which results from scrofula, we may legitimately include many of the diseases to which articulations are liable.

2. *Fibro-cartilage.*—This tissue established by Bichat, and termed by Beclard cartilaginiform ligament, is met with principally in joints of the second order, in which it forms the chief bond of union between the bones, though occasionally occurring as an accessory structure in joints of the third or more complex form. It is composed of fibrous and cartilaginous tissues, usually disposed with more or less regularity in alternating masses. Vessels have been traced into the substance of fibro-cartilage, but under ordinary circumstances they are not discernible; and the tissue, both in its physical properties, its low degree of organization, and its morbid appearances, presents a close resemblance to cartilage. Its diseases are very obscure, and much yet remains to be done towards elucidating them. When divided it re-unites, as is seen after the operation of symphysiotomy. Under certain circumstances we find it unusually developed, as when, for example, in consequence of subsided caries or disease in the intervertebral substance, a lateral curvature of the spine takes place. Bony ankylosis ensues on the compressed side, but on the opposite side the intervertebral substance becomes stretched and elongated. "The fibro-cartilages," says Velpeau[1], "may imbibe fluids, and we sometimes see them swollen so as to produce a considerable separation between the bones which they unite:" thus the symphysis pubis separates, to a small extent, at the time of delivery. Delpech[2] has noticed a sort of white swelling commencing in this tissue, and affirms that hydarthrosis may take place in the fibro-cartilaginous articulations. Ulceration is not a very uncommon occurrence in them. "In two instances," says Mr. Porter[3], "I have seen the intervertebral substance eroded at the anterior edge, the bodies of the adjacent vertebræ remaining unaltered in shape or consistence, and to every appearance in a perfectly healthy state." In the Museum of Guy's Hospital is a preparation in which the bodies of two vertebræ, entire in all their parts, and healthy, are completely separated from one another, by destruction of the inter-

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[1] Anatomie Chirurgicale.

[2] Précis Elémentaire, &c,

[3] Cyclopædia of Anatomy and Physiology, art. BONE.

vertebral substance. Sir Astley Cooper[1] believes psoas abscess to commence by disease between the spinal ligaments and intervertebral substance; with this opinion Mr. Key[2] coincides, believing that the fibro-cartilaginous tissue being little organised, and incapable of resisting the tendency to break down and ulcerate, is often the first structure attacked, while the bone, more vascular and highly organised, resists. A softened and apparently swollen state of this tissue is not unfrequently met with, and may be reasonably supposed to constitute the first stage of the ulcerative process. Fibro-cartilage shows a remarkable power of resisting the effects of pressure, and is sometimes found entire when the bodies of the vertebræ have been almost entirely removed by the pressure of an aneurismal sac. This is commonly attributed to the feebleness of organization, but may be also ascribed in a great measure to the remarkable elasticity with which this tissue is endowed. In fine, the fibro-cartilage has a strong tendency to ossification. Ankylosis of the bodies of the vertebræ is one of the most common of senile changes, and I have seen the cotyloid ligament of the acetabulum completely ossified, and forming a very distinct rim around the articulation.

3. *Ligament.*—Ligamentous tissue is met with in articulations in two forms: either as a broad layer of membrane enveloping the heads of the bones, and expanded on their surfaces, or in narrow funicular processes, stretching like cords between two points, and connected to bone only at the two extremities. It presents well-marked fibres, white, silvery, flexible, inelastic, and readily separable by macerations; no nerves, and but few vessels have been traced into its substance. It has no contractility, and in the healthy state, no sensibility. The important part which ligaments perform in articulations, and their liability to external injuries, furnish a presumption, that they contribute in no small measure to the diseases of these organs: but observations are as yet wanting to prove that they are the nidus of any serious articular disease. "I have never," says Sir B. Brodie[3], "met with a case where disease (independently of the effects of accident or of syphilis) was proved by dissection to have originated in the ligaments, and it may be safely asserted that this is a rare occurrence, and not what happens in the ordinary diseases to which joints are liable." Mr. S. Cooper[4] advanced many years ago, the opinion that white swellings generally commence in the ligaments, and within the last few years Mr. Key[5] has pointed out as a very common cause of disease in the hip-joint, ulceration of the ligamentum teres. In proof of this latter opinion, some striking cases are adduced, and those who are in the habit of examining diseased joints must have frequently observed this appearance. In fact, the frequency of its occurrence is sufficiently attested by the common spectacle of luxated femur following morbus coxarius. It will, however, be remembered, that when caries is proceeding, the ligaments rapidly lose their connexion with the carious surface. If, therefore, there be truth in the opinion already stated, that disease of the hip-joint, like disease of other articulations, frequently commences in caries of the articular extremities of bone, there will be some reason for believing that the destruction of the ligamentum teres arises from this source, and is a secondary not a primary lesion. It is, however, unquestionable, that ulceration of ligamentous tissue may take place, as the primary lesion. In the Museum of Guy's Hospital is a preparation in which the transverse ligament of the atlas has been ruptured in consequence of ulceration, and in which the ligament seems to be the only tissue affected. The early appearances of inflammation of ligaments have been very clearly described by Mr. Key. He states that the ligament becomes distended and feels pulpy; the fibres are found separated by a vascular structure which, on injection, has a villous appearance. This interstitial vascular mass is the reticular membrane that unites the ligamentous fibres. It becomes very vascular while the ligamentous fibres retain their natural glistening appearance, until at length they become softened and pulpy previously to undergoing absorption.

Although the ligaments are not as yet proved to originate any of the more serious diseases of joints, yet we seldom fail to find them implicated in the diseases which have commenced in other tissues. Intimately connected with both synovial membrane and bone, morbid changes are rapidly propagated to them from these tissues. In the advanced stage of ulceration of cartilage, or articular osteitis, the ligaments are frequently indiscernible in the mass of altered synovial membrane and cellular tissue, densely infiltrated with lymph which surrounds the joint. It is not improbable that they play an important part in producing the pain which attends diseased joints, as from their firm and unyielding character, they offer a great resistance to the distension occasioned by the accumulation of fluids within the cavity.

Among the few morbid changes of ligaments with which we are acquainted, the state termed diastasis, or relaxation, must not be forgotten. This is a condition gradually brought about by the long continued application of some elongating or distending force. Thus we see it frequently after the cure of hydrops articuli, or in the knees of children, who, from ill-health or other causes, not learning to walk, are carried on the arm of a nurse, with the legs hanging down unsupported, or in the shoulder-joints of persons whose arms are paralytic, and in whom the muscles, which form an important portion of the capsular ligament, losing their contractile power, suffer the weight of the arm to be borne by the ligament alone. An example of it may also be seen in the sinking of the arch of the foot described by Mr. Key in the third number of the Guy's Hospital Reports.

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[1] Sir A. Cooper's Surgical Lectures in the "Lancet."

[2] Med. Chir. Transactions, vol. xviii. p. 1.

[3] Brodie on the Diseases of Joints.

[4] Vide Mr. Cooper's Jacksonian Prize Essay.

[5] Med. Chir. Transactions, vol. xviii. p. 1.

4. *Synovial membrane.*—We here arrive at the only highly organized tissue which enters into the composition of joints. The articular synovial membranes are thin, soft, and translucent, well supplied with blood vessels, but not manifestly endowed with nerves, and secrete from their internal surface a viscid oily fluid, which serves to lubricate the motions of the hard structures. On the internal surface of many of the synovial capsules, chiefly at the margins of the cartilages, there are found plicæ, or reduplications of the membrane, analogous to the valvulæ conniventes of the intestines, and which contain within their folds, but external to the cavity of the joint, small pellets of fat, erroneously supposed by Havers and Portal to be glands secreting synovia.

The synovial membranes have been ranked, by Bichat and Beclard, among the serous, to which they present several analogies, but their peculiarities are sufficiently marked to constitute them a separate class. By the majority of anatomists, among whom may be mentioned W. Hunter, Sœmmering, Bichat, Meckel, and Beclard, they have been regarded as forming shut sacs, but this opinion has been impugned by Majendie, Gordon, Cruveilhier, Velpeau, and others, and as the question is one by the decision of which our pathological views must be considerably influenced, it will be necessary to enter into the discussion. It is affirmed by the authors last mentioned, that the synovial membrane is merely extended between the extremities of the bones, in the form of a capsular membrane, and does not extend over the surface of the cartilage. The arguments which they advance in support of this proposition are to the following effect :—1. Careful dissection does not separate from the surface of the cartilage any distinct membrane ; or, if a membrane be raised it is only a thin lamina of cartilage, which is made to assume that form. 2. In inspecting diseased joints, where the free synovial membrane is densely injected, the cartilaginous surface retains its natural colour and healthy aspect, nor can delicate injections be made to pass over the surface of the cartilage. 3. If the joint of a living animal be freely exposed to the air, the cartilaginous surface becomes quite dry, while the synovial membrane extending between the bones is moistened by its natural secretion. 4. After disarticulations, when the cartilaginous surfaces remain exposed to view for many days, no morbid change developes itself, indicative of the presence of a synovial membrane, and the cartilage at length scales off in patches, or is lost amidst a crowd of granulations.

To these arguments it may be replied, that the synovial membrane covering cartilages is placed under circumstances widely different from those of a membrane expanded between the ends of bones. Exposed to constant pressure between two dense structures, it must necessarily have a most intimate union with the tissue over which it is spread, and the same cause must forbid the development in the normal state of vessels sufficiently large to convey red blood. We have an example of this adaptation of structures to meet particular circumstances in the change which the tunica conjunctiva assumes when it is expanded over the cornea. An analogous example is found in the arachnoid lining the dura mater, which from the comparative infrequency of its morbid changes, and the closeness of its union with the fibrous membrane to which it is superposed, has been affirmed by some not to exist : though the hæmorrhage which sometimes takes place between the two tissues as pointed out by Dr. Hodgkin[1], and many other evidences, are conclusive proofs to the contrary. It must be granted, therefore, that the synovial membrane, when reflected over cartilage, undergoes a great modification, but the following facts tend strongly to show that it still exists :—

1. By careful dissection, especially after continued maceration, a membrane can be distinctly raised from the surface of the cartilage, thin and transparent like a serous membrane, and continuous with the loose synovial membrane stretching between the bones. A more easy demonstration is effected by incising a layer of the cartilage, and then bending it back until the base by which it remains attached is broken : it will still hang pendulous to the surface of the joint, and if it be torn away cautiously, a piece of membrane, half an inch or an inch long, may be brought away with it. It cannot be supposed, that this membrane is a thin layer of cartilage, because cartilage being made up of perpendicular fibres attached to the bone, will not separate at right angles to its fibre or "across the grain," and also because the membrane thus demonstrated is so flexible that it may be rolled up, and again spread out, which would be impossible with a layer of cartilage however thin. "The existence of synovial membrane or cartilage," says Sir B. Brodie, "may be always demonstrated by a careful dissection."

"I am convinced by dissection," says Larrey[2], "that a very fine and delicate prolongaation of the internal fold of the synovial capsule covers the articular surface of the cartilage, to which this membranous pellicle is so intimately united that we can detach it only with the greatest difficulty and most delicate dissection. . . . . After having raised the pellicle, the cartilage, laid bare, offers rugosities."

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[1] Hodgkin's Lectures on the Morbid Anatomy of the Serous and Mucous Membranes, vol. i.

[2] Mémoires de Campagnes et Chirurgie Militaire, tom. ii. p. 425.

2. The bursæ mucosæ, which are structures in every way analogous to synovial membranes, the two being sometimes continuous and communicating with one another, as Meckel has pointed out, and the thecæ of the tendons, are indisputably shut sacs.

3. We occasionally see, in examining healthy joints, an extension of vessels from the free synovial membrane for a small distance over the surface of the cartilage. In examining the knee-joint of an adult fœtus injected with fine size, I could distinctly trace a number of injected vessels crossing over the surface of the cartilage nearly half way to the centre of the articulating surface of the femur. It is admitted by Cruveilhier and Velpeau that it is impossible to point out the line of demarcation between the synovial membrane and the uncovered cartilage, and this admission, combined with the presence of vessels, may go far to show that no such line of demarcation exists.

4. If we appeal to morbid appearances, the evidence is equally conclusive. In examining preparations of joints in which the cartilage is still entire, it is impossible not to be struck with the shreds of membrane which are seen hanging from the cartilaginous surface, sometimes light and flocculent, like floating villi, at other times broad and distinct. Whether these shreds are regarded as portions of synovial membrane, or as false membranes resulting from inflammation; they tend to prove the same point. Again, a cartilaginous surface may contract adhesions. Velpeau, without attempting to account for the phenomenon, affirms that after disarticulation, if union takes place by the first intention, the flaps adhere to the surface of the cartilage. In a case of osteo-sarcoma, affecting the lower portion of the femur, described by Sir B. Brodie, the femoral cartilage was found to be expanded over the tumour, and in several places to have contracted adhesions to the cartilage on the head of the tibia. In the Museum of Guy's Hospital there is a preparation in which the cartilage of the patella remains entire while a fine cellulo-membranous adhesion, nearly an inch in length, is seen stretching from it to the femur, of which the cartilage has been removed by ulceration. Other preparations show the same phenomenon, but from the ankylosis being closer, not with the same indisputable clearness. Mr. Mayo[1] notices a similar appearance in a knee-joint preserved in the King's College Museum.

Under acute inflammation, red vessels are occasionally developed on the surface of the cartilage, spreading from the circumference to the centre, exactly as the vessels of the conjunctiva covering the transparent cornea, become developed under similar circumstances. "In inflammation of these membranes," says Beclard[2], "their redness, which at length becomes perceptible, extends itself upon the circumference of the cartilage, gradually becoming less as we approach the centre of the membrane, identifying itself more and more with the cartilage; the centre itself in the end is penetrated by vessels, but the cartilage is coloured only on its surface, and preserves in its substance the white colour natural to it." I have never seen the redness extending quite to the centre, but I have seen it advancing towards that point. There is a preparation in the Guy's Museum which shows the synovial membrane of the semilunar cartilages, which does not naturally carry red blood densely injected, and in one of the cases detailed by Mr. Mayo[1], he states that the vessels of the synovial membrane, covering parts of the cartilage of the patella, the inner condyle and the semi-lunar cartilages, were filled with injection. A few similar facts will complete the argument. Hey, a most cautious observer, states[2], that in a case of compound dislocation of the ankle-joint, he distinctly saw granulations arising from the cartilaginous surface of the astragalus. In three out of eight cases of the pulpy degeneration of synovial membrane described by Sir B. Brodie[3], the alteration had extended more or less completely over the cartilaginous surfaces, the cartilage beneath remaining entire. Cruveilhier[4] himself, states that he has seen fungous granulations arising from a cartilaginous surface, and candidly admits his inability to account for the phenomenon consistently with his own hypothesis. Mr. Mayo cites a case similar to that detailed by Cruveilhier. Lastly, we find that cartilage becomes yellow in icterus, and that, in those cases of gout in which the urate of soda is copiously deposited in the interior of a joint, the deposit takes place not merely on the free synovial membrane, but also on that covering the cartilage.

I have entered at length into the discussion of this question, not only because it is in itself of great importance, but also as it is intimately connected with some other disputed points presently to be brought under notice. The facts and arguments seem pretty conclusive, and I proceed to point out that the synovial membrane is more prone to disease than any other articular tissue. It is susceptible of inflammation in all its forms. Cases have already been quoted in which ankylosis had taken place between the cartilaginous surfaces, and in which, consequently, there had been adhesive inflammation. In the first case cited, and in Sir B. Brodie's work, there was found a thin flake of coagulated lymph about the size of a half crown-piece effused from the inner surface of the synovial membrane; and the author states that he has seen several cases in which there was every reason to believe that inflammation had produced adhesions more or less extensive of the reflected folds of the membrane to each other, and has occasionally observed such partial adhesions as may be supposed to have arisen from inflammation at some former period. This phenomenon, however, is not of very common occurrence. More frequently we meet with an inflammation attended with copious secretion of altered synovia. This may assume the most mild form, revealing itself only by swelling, a feeling of fluctuation when the joint is pressed upon, and a very slight degree of weakness and uneasiness in the limb. This state constitutes what is commonly termed hydrops articuli. By the surgeons of the last age it was classed as a distinct disease, but no good reason can be assigned for excluding it from among the forms of synovitis. In a more decided state of inflammation, the swelling of the joint is less notable, but the pain is greater though still not severe, and unless checked, the disease slowly, but certainly, proceeds to attack every other tissue in the joint, and produces the most complete and remediless disorganization. Between this chronic form and the most acute, the inflammation may assume various shades of severity, which have been most clearly and graphically sketched by Mr. Key, in the Med.-Chir. Transactions. The various forms blend into each other so imperceptibly, and one may so rapidly pass into the other, (the most chronic into the most acute, or *vice versâ*,) that it is impossible to draw any clear lines of distinction between them. In the most acute form, the disease may entirely and permanently cease after the lapse of a short time, as we occasionally see in traumatic synovitis occurring in a healthy subject; or it may subside into a chronic action, continuing for months or years, always liable to become again acute, and to involve the surrounding structures; or it may take on a suppurative form, producing speedy ulceration of the membrane, and placing the patient's life and limb in imminent peril.

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[1] Med.-Chir. Transactions, vol. xix.

[2] Anatomie Générale.

[1] Med.-Chir. Transactions, vol. xix.

[2] Practical Observations, &c.

[3] Brodie on the Diseases of Joints.

[4] Archives Générales de Médecine, 1824.

Sir Benjamin Brodie has described as something distinct from inflammatory action, and corresponding to the heterologue deposits, such as cancer and tubercle, a pulpy degeneration of the synovial membrane. The symptoms which usher in, and accompany this disease, and the course which it pursues, bear a close resemblance to chronic synovitis. I have in one instance seen appearances precisely similar to those described by Sir Benjamin. The synovial membrane passing from bone to bone, and forming the mucous ligaments, was thickened to about the third of an inch, firm and elastic, of a light yellow colour, chequered by white striæ. In this case, the history and symptoms appeared to indicate that the disease had commenced in the bone, and this was confirmed in a great measure by the state of the bones and cartilage discovered on examining the limb after amputation. Until some further light is thrown upon the subject, it may be allowable to include the disease among the forms of synovitis. The synovial membrane may, however, be the seat of very distinct heterologue formations, as will be seen by a reference to the article "Diseases of Synovial Membrane."

Along with the diseases of the synovial membrane itself, it will be most in accordance with the practice of modern pathologists to mark the diseases incident to the sub-synovial cellular tissue. This tissue, of which the existence between the cartilage and its lining membrane is only inferred from analogy, is very fully developed around the other portions of the synovial capsule. It shares in the inflammation of the membrane to which it is attached, and, becoming infiltrated with lymph, tends materially to produce the thickened state of the synovial membrane commonly observed in diseased joints. The most interesting light, however, in which it can be regarded, is as the nidus in which are developed the loose cartilages of joints which have so long engaged the attention of pathologists. The union of many observations has now furnished a tolerably clear account of the origin of these bodies. They are rarely, if ever, purely cartilaginous, but are composed of a mass of bone covered with a layer of cartilage. They seem to originate in some comparatively slight and local inflammation of the sub-synovial cellular tissue. In all the cases related by Hey, their formation had been preceded by a sprain or contusion of the joint in which they occurred, aud some other observers have noticed the same antecedence. M. Velpeau supposes[1] that this accident had determined a slight extravasation of blood in the cellular tissue, and that this extravasated blood becomes organized; but facts are yet wanting to show the possibility of such a process, and it is more in accordance with known pathological phenomena to suppose that an effusion of plastic lymph takes place, which becomes penetrated by the vessels of the surrounding parts. Remaining in this situation, they gradually assume the osteo-cartilaginous character. Analogies to this transformation may be found in the cartilaginous patches frequently met with on the surface of the liver and spleen, in the large osseous masses which form behind the pleura after an old pleuritis, and in the plates of cartilage which are observed at times on the attached surface of the arachnoid. The cartilaginous incrustation which covers them furnishes an example of the very curious and interesting law pointed out by Dr. Hodgkin[2], that the character of a new product is influenced by the character of surrounding parts. They have been found by many observers in this situation lying beneath the synovial membrane. Protruding this membrane before them like a hernial sac, they impinge upon the articular cavity, at first attached by a broad base, which gradually becomes narrower, until it is reduced to a slender peduncle, after which the connexion is speedily broken and the body becomes loose in the joint. This process has been traced through all its stages. Sir B. Brodie has seen them covered by the synovial membrane. Begin[1] states that he has met with them sometimes lying beneath the capsule, and scarcely projecting into the joint, at other times hanging by a long and slender peduncle. In the Museum at Guy's Hospital, is a preparation which shows four of these bodies in the elbow; two appear to have been lying loose, but the other two are attached to the synovial membrane by slender filaments. In Cruveilhier's ninth *Livraison*, a very beautiful plate is given in which these bodies are figured in the knee-joint. Two small ones are lying beneath the synovial membrane without producing much protrusion; a third is more prominent, and pushes forwards the membrane distinctly; while a fourth, just ready to be detached, is hanging into the cavity by a long and delicate pedicle. The subject of loose cartilages may, therefore, in consistence with the guidance of a sound pathology, be considered along with the diseases of synovial membrane.

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[1] Anatomie Chirurgicale.

[2] Lectures on the Morbid Anatomy of the Mucous and Serous Membranes, vol. i. London, 1836.

From the synovial membrane, I proceed to the only tissue which yet remains to be considered.

5. *Cartilage.*—Articular cartilage presents itself in two forms, either synarthrodial, such as is met with between the sutures of the cranium, or diarthrodial, as it occurs in the more complex articulations. In this latter form, it is found to be a dense, very elastic substance, intimately connected by one surface to the head of the bone, and on the other lined by a synovial membrane. After long maceration, it is found to consist of straight and parallel fibres, arising, says Dr. Hunter[2], from the bone like the pile of velvet. Its organization is probably inferior to that of any other tissue. Nerves have not been traced into its structure, nor in the healthy state red vessels. "The cartilages," says Meckel[3], "do not receive vessels which convey red blood, although in cutting them we frequently perceive distinct vessels in their substance." From some observations recorded by two careful anatomists, W. and T. Arnold, in the Physiological Journal of Tiedemann and Treviranus, it appears that in the fœtus of the fourth, fifth, and seventh months, the articular and permanent cartilages consist of numerous granules. The temporary cartilages exhibit the same structure, but in particular points are more closely approximated. These points are more distinct as ossification advances. In adults, they state that cartilage appears to be a white mass composed of granules irregularly heaped together. These masses contain interspaces which are for the most part four, five, or sexangular, but irregular, and sometimes more of a rounded, oval, or other form.

I have been more particular than I should otherwise have been in describing the general anatomy of cartilage, because Messrs. Velpeau and Cruveilhier, the one the most learned surgeon, the other the most eminent pathologist in France[1], have adopted the opinion that the articular cartilage is a mere epidermic crust, endowed with no organic life, and hence insusceptible of disease.

These novel opinions are supported by some plausible arguments, and as the influence which they are calculated to exert on our pathological views is of great consequence, it will be necessary to enter into an examination of them. The doctrine was first, I believe, propounded by Cruveilhier, in a paper read before the Philomathic Society, in the latter part of the year 1823, and published in the Archives Générales for February, 1824. The arguments which he adduces are to the following effect:—

1. Lay bare an articulation: treat the cartilage violently by pulling, pinching, cutting, or tearing it; and it will evince no signs of inflammation, nor will there be the smallest pain produced.

2. If the spongy extremity of a bone be perforated by a piercing instrument, or a heated iron, and the cartilage bruised or simply touched, without the application of any force to destroy its texture, still the result is the same; nothing ensues but elimination or absorption.

3. Where necrosis takes place, though frequently a very thin lamina of living bone separates the dead bone from the cartilage, the cartilage remains sound.

4. Cartilages laid bare in disarticulations, either fall off or do not become attached to the soft parts.

5. Cartilage, when broken or divided in its continuity, does not offer any token of reparative effort.

6. In reading the accounts of the dissections of diseased joints, we generally find the striking clearness and healthy appearance of the cartilage contrasted with the extent of the surrounding lesions.

7. In ankylosis, the cartilage is invariably removed.

These arguments are in the main repeated by M. Velpeau, in his Anatomie Chirurgicale. The cartilage, he says, being only an incrustation without organic web, cellular tissue, vessels, nerves, or marrow, the whole thickness of the cartilage enjoys no sensibility. Hence, it cannot be the primitive seat of any malady. It never inflames nor suppurates. The cellular patches which we sometimes observe over the whole surface of the cartilage are foreign to it. They spring from the osseous substance. Sometimes they are shown at once upon the cartilaginous patches which they have raised; at other times, they cross over from the circumference to the centre, but the cartilage always disappears before them without ever contributing to produce them. After disarticulations, the cartilages will remain in contact, with dressings, for many days without undergoing any morbid change. They fall off by patches, or disappear in the midst of vascular layers of membrane, but never show any trace of synovial membrane, softening, vascularity, thickening, or any other morbid lesion: a true epidermis of the bones, they retain merely the characters of a protecting crust, entirely inorganic, and susceptible only of physical and chemical lesions. No ankylosis can take place until the cartilage is removed.

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[1] Dictionnaire de Médecine et Chirurgie Pratique, Art. Corps Etrangers.

[2] Hunter on the Structure and Diseases of Articular Cartilage. Phil. Trans. vol. xlii.

[3] Meckel's General and Descriptive Anatomy.

[1] The views of these gentlemen may be found in the Archives Générales de Médecine, vol. iv. 1824. Dictionnaire de Médecine et Chirurgie Pratique, art. Articulations. Anatomie Chirurgicale, par Velpeau.

Of the facts and arguments here adduced, some are most undoubtedly mistakes; while others, though true in themselves, are explicable on another principle than the absence of vitality. To the former class belongs the assertion made by Cruveilhier, and repeated by Velpeau, that ankylosis can never take place until the cartilages are removed. In a former part of this article, I have cited examples in which distinct bands of adhesion, constituting soft anchylosis, are attached to the cartilaginous surface, and I have also cited the concurrent testimony of Brodie and Mayo to the same purport. The proposition laid down by Cruveilhier, that after disarticulation the flap does not adhere to the cartilaginous surface, is refuted by Velpeau himself, who even chides Beclard for asserting the contrary. The affirmation of Velpeau, that the cartilages never swell, soften, or exhibit any morbid lesion, is equally incorrect, as I shall presently show; and not less fallacious is the assertion of Cruveilhier, that when a solution of continuity takes place, the cartilages show no trace of reparative action. On the contrary, if a divided cartilage, whether articular or sterno-costal, be examined some time after the division has been made, a tissue, not indeed cartilaginous, but more allied to ligament, will be found uniting the incised surfaces and closely adherent to each. To the remaining arguments adduced, which are drawn entirely from the persistent character of cartilage and the slowness with which it takes on any morbid action, it may be replied that this tissue is unquestionably of low organization, and presents few changes, but that if one single example of morbid change can be satisfactorily established, the whole argument on their part falls to the ground.

It is true that cartilage may be lacerated and bruised without the production of any of the ordinary signs of inflammation, heat, redness, pain, and swelling; but the ligaments and fibro-cartilages, both of which are confessedly endowed with vitality, may be treated in the same way, and the former will at the time evince no sensibility, while the latter will not present any traces of inflammation more distinct than those evinced by cartilage.

The following considerations may also be urged as directly contravening the views of Messrs. Velpeau and Cruveilhier.

1. It is difficult to conceive how the cartilage, if merely inorganized matter, can keep pace with, and undergo, changes corresponding to the gradual development of the animal. Adapted in infancy to the small size of the articular surfaces, it augments in bulk and expansion as life advances. Though exposed to constant pressure and a degree of friction which no inorganic substance with which we are acquainted could endure without sensible diminution, it maintains its form and volume uninjured. As life advances, it undergoes changes corresponding to those observed in other tissues. In the fœtus soft, muciform, and transparent; in the infant still transparent, soft, and but slightly elastic; in more mature years assuming the dense, hard, and elastic character by which it is commonly known; it becomes in old age, yellow, more dry and opake, less flexible, less elastic, loaded with a greater portion of earthy matter, and sometimes in the end completely ossified. Surely these circumstances tend to show that a process of nutrition is constantly going on,—obscure, indeed, to our perceptions, but which we ought not to deny simply because we cannot comprehend.

2. From this point of view let us turn to consider the evidence deducible from tissues identical with, or closely analogous to, articular cartilage. Beclard and the majority of anatomists assert that in the fœtus the articular is distinctly separate from the temporary cartilage, but an actual examination of fœtal limbs will show that his observation is by no means universally correct. In the full-grown fœtus, except where the process of ossification is very far advanced, I, and others with me, have several times failed in discovering any actual line of demarcation, and even when ossification is advancing, the temporary cartilage interposed between the vessels and around the osseous spots, has precisely the diaphanous gelatinous appearance which is seen at the extremity of the bone. The minute observations of the Arnolds, already quoted, tend to the same conclusion. If, therefore, the tissues be so clearly correspondent, is it not reasonable to infer when the one is manifestly endowed with life, that the other possesses the same attributes? Again, the cartilages of the ribs, and the thyroid and cricoid cartilages, which so closely resemble articular cartilage in physical properties and intimate structures, betray evident tokens of vitality. They are invested by a distinct membrane; after division they reunite, and as life advances, they are frequently the seat of accidental ossifications. At the period of puberty, the thyroid cartilage undergoes a manifest and extraordinary change, which argues a great activity of nutrition, and every surgeon has seen ulceration of this structure, following

syphilis treated by mercury. Here, therefore, the argument from analogy has great cogency, and the morbid changes which the fibro-cartilages undergo furnish additional evidence of the same character.

3. The conclusions deducible from morbid anatomy are still more striking and decisive. It is true that the effects of diseased action are not displayed in articular cartilage in the same way as in most other parts, but it must be remembered that the phenomena of ulceration vary with the varying tissues in which they are manifested. Whatever view we may adopt of the ulcerative process, the fact will remain the same, that this action goes on in cartilage. Very frequently, on opening a joint, we find the cartilage removed at some points, and the bone exposed; around the margins of this denudation the cartilage is seen to be distinctly softened, a little swollen, and bevelling down upon the bone; while in other parts the same process has produced slight pits and fossæ on the surface, not yet extending to the osseous structure. I have several times distinctly and carefully noticed this appearance, which is inexplicable on any other supposition than that the process commences in the cartilage itself, and its occurrence has been confirmed by the testimony of other observers, among whom I may cite Brodie, Hey, Mayo, and Wickham. In other cases, as Beclard and many others testify, we find the cartilage not having as yet undergone any actual destruction, but softened or even pulpy, and hanging in villous fibres, or fringed brush-like projections into the cavity of the joint.

In the Dictionnaire de Médecine et Chirurgie Pratique, Cruveilhier himself describes this state of things, and candidly avows his inability to account for it, unless by a process instituted within the substance of the cartilage itself. Another statement made by Cruveilhier, in his ninth *Livraison*, to the effect that after gout he has found the urate of soda deposited not merely on the free surface, but in the very substance of articular cartilage, is equally irreconcileable with the opinion that this tissue enjoys no organic life. In the Museum of Guy's Hospital there is an interesting preparation of the hip-joint, in which ulceration is seen to be proceeding at the edges of the femoral cartilage, and in the neighbourhood of the ligamentum teres. At a little distance from this ulceration are seen two or three much raised button-like projections, not having the fibrous brush-like appearance already described, but of uniform surface, and closely resembling the protrusion which takes place of the semifluid centre of the intervertebral substance, when the bodies of two vertebræ are separated. Around these projections the cartilage is entire. I am at a loss to account for this appearance, and have never seen anything precisely similar; but the conclusion to be drawn from it, that the tissue in which it occurs must be organized, is undeniable. In fine, it may be added, that Brodie and Mayo concur in asserting that in cases where ulceration of cartilages has been consequent to articular osteitis they have repeatedly seen red vessels passing into the substance of the cartilage.

From this mingled series of analogies and facts may be deduced the conclusion that the articular cartilage is a living tissue, susceptible of morbid action, and amenable to the same great laws of life which preside over every other portion of the frame. There yet remains to be noticed a doctrine connected with the ulceration of cartilage, similar in some points to that advanced by Cruveilhier and Velpeau, as it is founded on the confessedly low organization of this structure, but incomparably better supported by facts and arguments. I allude to the ingenious and original views propounded by Mr. Key in a paper on the Ulcerative Process in Joints, published some years ago, in the Med.-Chir. Trans., and subsequently supported by further observations transmitted to the public through the same medium. Very erroneous views have been entertained with respect to these opinions, and I shall seek to state them as concisely and clearly as possible. Mr. Key admits that primary ulceration of the cartilage may, and does, occur, but contends that the removal of cartilage, which takes place consecutively, to synovitis, or osteitis, is not an ulcerative act commencing in the cartilage, but a process of absorption set up by the surrounding previously affected tissues, for the removal of a body obstructive to the process of ankylosis by which a disorganized joint is repaired.

To show that such a process may be carried on by the vessels of one tissue upon another, Mr. Key cites the case of a necrotic bone in which the portions of sequestra corresponding to the cloacæ in the new shell are found smooth and entire, while those completely surrounded by the regenerated bone are worm-eaten, in consequence of absorption instituted by the villous fringes prolonged from the interior of the living case. The other arguments urged by Mr. Key are principally as follows:—cartilage is of such low organization, that absorption can scarcely be supposed to take place within its structure. After synovitis, and where ulceration of cartilage has occurred, this process is generally found to have commenced at the margins of the cartilage, and vascular prolongations from the synovial membrane are found loosely attached to the ulcerating spots. A similar state of things is observed in those cases where grooves are formed along the cartilaginous surface. To these grooves a highly-injected and newly-developed false membrane accurately applies. Where ulceration follows osteitis, the cartilage is first removed on its attached surface; and where this process of removal is going on, a vascular membrane is found to have shot up from the surface of the bone.

I am ready to confess that the preparations adduced by Mr. Key in support of these views are very striking, and that the principle of absorption, by the vessels of another tissue, would solve some difficulties in the pathology of cartilage; but there is reason for believing that greater difficulties would follow its adoption. In the first place, as to the example of a necrotic bone, it must be remembered, that facts are still wanting to prove the possibility of the absorption of a foreign solid body, such as a dead bone, by living vessels. Bullets and shot remain for years imbedded in the body without undergoing any perceptible change; and dead bones have been inserted into the medullary canal of living bones, have remained there for years, and on examination have been found entire. Indeed, it occasionally happens, that the whole of the dead shaft of a bone, whether opposed to cloacæ or not, preserves its smoothness; and the more common occurrence of an irregular surface, smooth at one place and worm-eaten at another, may be accounted for by the fact which has been clearly established by Weidmann in his erudite and masterly Treatise on Necrosis, that often the centre of the shaft does not perish, but the bone dies irregularly. If, however, it were admitted, that this process of absorption does take place in necrosis, the argument, though rendered more probable, would still be inconclusive, inasmuch as there is a want of analogy between dead bone and living cartilages. The difficulty would still remain, that we know of no instance in which the vessels of one tissue, or of a newly developed membrane, are employed to effect the destruction of another tissue. And the argument may be pushed still further. It has been already established, that the cartilage is invested by a synovial membrane. In those cases in which the absorption is said to commence on the free surface, as in synovitis, the vessels which carry on the process must make their first ravages on the membrane. If, therefore, the opinion combated be adopted, we shall have here the anomalous spectacle of a suicidal membrane prolonging its vessels, or throwing out a new membrane to effect its own annihilation; like the fabled scorpion, girt with fire, that turns its venom inwards, and perishes self-destroyed.

The argument drawn from the common commencement of ulceration at the margin of the cartilage, will apply equally to another view of the process by which this is effected. If, as there are many reasons for believing, the destruction of the cartilage commences by an inflammation propagated to it, from the inflamed synovial membrane, in obedience to the law of morbid action which so frequently connects pleuritis with pneumonia, and which reveals to the practised surgeon the state of a hernial sac by the state of its investments, then it is easy to perceive why that portion of the cartilage which is in closest proximity to the inflamed membrane should first be affected. In a similar way the vascular prolongations which are found in the interior of a joint may be shown to be simply the ordinary results of inflammation, and not necessarily endowed with powers unknown in any other organ. These vascular fringes are of two sorts—sometimes abnormal developments of the synovial tissue, at other times actual productions of a new membrane. In the first case, the folds or reduplications which, as was observed in the brief sketch of the anatomy of synovial membranes, are frequently seen in the interior of a joint, and most commonly at the margin of the cartilage, become, under inflammation, excessively tumid and injected, and overlap the cartilage, exactly as in pannus or pterygium, the conjunctiva becomes enormously developed, in consequence of inflammation. In the second case, where a new membrane is thrown out, we have a state precisely similar to that which is every day seen in the serous membranes, when coagulable lymph is effused, and being permeated by the vessels of the neighbouring parts, acquires organization. It may be farther observed, that ulceration of cartilage follows synovitis in joints which, from their form and construction, seem scarcely capable of admitting the prolongation of vascular fringes between the articular surfaces; as, for example, the wrist and tarsal joints. In fine, since in the intervertebral substance, which is scarcely, if at all, superior in vitality to articular cartilage, ulceration may go on, though no synovial membrane is involved; and, since it is admitted, that ulceration of cartilage may occur as a primary affection, does it not seem fair to conclude, that the removal of this tissue, when occurring as the secondary effect of adjacent lesion, is self-effected, and does not require the intervention of a process different from any which is known to occur in other positions of the frame?

If the opinions now advocated be correct, the account which may be given of the diseases incident to articular cartilage is brief. There seems to be no intermediate stage between inflammation and ulceration, unless we are to regard as such the slightly swollen and softened state in which cartilage is sometimes found around an ulcerating spot. To avoid the necessity of a needless periphrasis, the term chondritis will be employed to designate this morbid condition. The tissue may be either primarily or secondarily affected. When primarily affected, the ulcerating process sometimes goes on for a long period without involving any other structure, but more commonly the surrounding parts speedily participate in the lesion, synovitis makes its appearance, the bone becomes inflamed, and at length the malady terminates, either in the establishment of ankylosis, or in the entire disintegration of the organ, demanding amputation or excision. When secondarily affected, the cartilage takes on a diseased action in consequence of the spread of inflammation from the seat of the primary lesion to the contiguous parts. If that primary lesion has been in the synovial membrane, the cartilage will ulcerate on its free surface, first becoming gradually thinner, till the bone is denuded; if in the bone, the reverse will happen, and a highly characteristic appearance will be presented on opening the joint.

Cruveilhier has described, as the only disease of which cartilage is susceptible, a rubbing or wearing away, in consequence of long-continued friction. It is evident that he is describing a process in which a certain change takes place in the cartilage analogous to ossification, and producing a remarkable eburnated or porcelain appearance of the head of the bone. This is rarely observed to happen, except as an accompaniment of rheumatism, and it will fall to be considered under the head of EBURNATION.

Under these heads, then, it appears that all the idiopathic diseases of articulations may be included consistently with the dictates of a sound pathology. But our view would be incomplete, were we to exclude two very curious and interesting processes which may not inappropriately be styled the efforts of nature to remedy the effects of disease—ankylosis and pseudarthrosis.

Ankylosis consists in the union of articular surfaces so as to limit or prevent motion. It may be osseous, as we frequently see in the vertebral column of persons advanced in life, or ligamentous, of which, examples are met with in old diseased joints. The former is called true, the latter, false ankylosis. The former is very common in articulations of the first and second order, which, indeed, are susceptible of no other species; the latter is more frequent in the third or most complex class of joints. A sort of pseudo-ankylosis is often met with, resulting from the rigidity of the parts surrounding a joint, or from the loss of the due balance of muscular action. The former is exemplified in the contractions which follow disease of cellular membrane around a joint, as described by Mr. Wickham, and in the contraction of the finger dependent on an abnormal state of the palmar fascia: the latter is exemplified by the rigidity of the phalangeal articulations in old cases of paralysis from lead.

Pseudarthrosis, or the formation of a false joint, is an extremely interesting phenomenon, and assumes several different aspects. It takes place in enlargement of the heads of the bones, in old ununited fractures, in unreduced dislocations, and after excision of the articulating extremities. Occasionally there seems to be an actual epigenesis, or creation of new tissues, and the new joint is endowed with an articular cavity, cartilage, ligament, and synovial membrane, of which examples, both in man and the lower tribes, have been recorded by Sir Astley Cooper, Mr. Key, Chaussier, Koëler, Wachter, and others. More commonly the joint consists simply in the connexion of two bones by a ligamentous structure, more or less flexible, but always admitting of a certain extent of motion. This is almost invariably the condition of the false joints formed after excision, or in old ununited fractures.

I have now explained and defended the classification of the diseases of joints which will be adopted in the Cyclopædia of Surgery. That it is open to some objections I am very sensible, but I know of no other arrangement which would be equally consistent with the actual state of our pathological knowledge. To resume, the present article may be considered as the prolegomena to the whole subject, and the different abnormal conditions of articulations will be considered under the following heads:—

1. Lesions resulting from external injury.
    - Wound.
    - Sprain.
    - Luxation.
2. Idiopathic diseases.
    - Articular ostëitis.
    - Diseases of fibro-cartilage.
    - Diseases of articular ligaments.
    - Diseases of synovial membrane.
    - Synovitis—acute and chronic.
    - Chondritis, or ulceration of cartilage.
3. Processes the result of disease, but not in themselves morbid.
    - Ankylosis.
    - Pseudarthrosis.

The reader will find these subjects taken up in their alphabetical order in other portions of the Cyclopædia.

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(*John Blackburn.*)

ASCITES (from ἀσκὸς, literally 'a wine-skin;' metaphorically, 'the belly'), abdominal dropsy, a complaint belonging to the province of medical pathology. Surgical treatment is, however, frequently required for its cure; and all particulars relating to such treatment will be found under the head PARACENTESIS ABDOMINIS.

ASPHYXIA, *apoplexia*, *suffocatio*, Lat.; *ἀσφυξία*, Gr.; *asphyxie*, Fr.; *Scheintod*, Ger.; *asfissia*, Ital.

By the word asphyxia is now generally understood a failure of the function of respiration, in consequence of which the other functions become arrested, and a state of the system induced which is correctly and familiarly known by the term *suspended animation.*

The derivation of asphyxia, therefore (*a*, and *σφύξις*, pulsus), which has reference to a failure of the heart's action, expresses but one of the many consequences that follow a suspension of the respiratory process, and does not imply the meaning attached to the word at present. The early writers used the term in its original acceptation, and of late it has been extended so as to include all varieties of suspended animation, such as proceed from lightning, gaseous poisons, and other agents known primarily to affect the brain and nervous system; the function of respiration being subsequently arrested. It has also been applied to that stage of malignant cholera which is marked by pulselessness and other symptoms of collapse. In *asphyxia*, however, the exciting cause, whatever it be, takes effect first on the lungs, the suspended function of which involves very rapidly those of the heart and brain; in *syncope* the exciting cause takes effect first on the heart, the suspended function of which extends instantly to those of the lungs and brain; and in *apoplexy* the exciting cause takes effect first on the brain, and involves, in an interval more or less prolonged, the functions of the lungs and heart.

Respiration is an essential function for the manifestations of life in all organized beings. By its influence a chemical interchange is effected between the nutritious fluid circulating within them and the atmospheric air by which they are surrounded. From the lowest vegetable production to man this chemical interchange has been observed; and in the higher orders of animals it cannot, for even a very short period, be put a stop to without the consequences being fatal. It is true that experiments have been made for the purpose of demonstrating that the respiratory function is not essential to the manifestations of life; and accordingly insects have been placed in vacuo and in irrespirable gases, and have been found to live for days. The fact, also, of worms supporting life in the alimentary canal has been adduced in confirmation of this opinion. But, even admitting in the first place the accuracy of the experiments alluded to, it by no means follows, because the vital manifestations of the beings experimented upon are not suspended even for days when thus deprived of the influence of the atmosphere, that respiration is not essential to their existence. Such experiments rather tend to prove the power those beings possess of supporting life, when thus unfavourably placed, *longer* than other animals in whom the organs of respiration are more centralized and more restricted to the performance of their special function. And when it is taken into account that a respiratory apparatus, on an extensive scale, exists in all insects, ramifying through their several delicate organs, thus bringing the air into close approximation with their tissues, and rendering at the same time their bodies specifically lighter; and that to this extensive respiratory apparatus the organs of circulation bear no proportion; it is a reasonable inference that the function of respiration is not only necessary to their continued manifestations of life, but that it is carried on in them with a degree of energy in full proportion to their wonderful activity. The accurate and interesting experiments of Mr. Newport on the temperature of insects, published in the Philosophical Transactions for 1837, show, that in an humble bee the number of respirations varied in one hour from one hundred and twenty to forty-six, in proportion to its excitement; and when confined in a limited quantity of atmospheric air a specimen of the same insect produced in an hour, whilst in a state of excitement, $\frac{1}{8}$ of a cubic inch of carbonic acid, and during the twenty-four hours of the succeeding day the animal evolved a quantity absolutely less. Neither does it follow that, because intestinal worms and other parasitic beings live, increase, and multiply within the hidden recesses of the living animals they inhabit, similar changes are not effected in their circulating fluids as in animals surrounded by the atmosphere. The vital fluids with which these creatures are in contact doubtless supply them with the means of carrying on the essential chemical object of respiration in a manner allied to the more perfect aquatic respiration of fishes.

Essential, then, as the function of respiration is to all living beings in a state of activity, it may, notwithstanding, be dispensed with altogether previously to the phenomena which indicate vital action taking place. Many instances are on record of seeds, eggs, and even some of the lower animals preserving, as it has been termed, their "latent life" for indefinite periods, without exercising any action on the surrounding atmosphere, and in some cases being altogether excluded from it. Professor Lindley records the following interesting account of seeds which retained their power of germinating for many centuries:—"I have now before me three plants of raspberries which have been raised in the gardens of the Horticultural Society from seeds taken from the stomach of a man whose skeleton was found thirty feet below the surface of the earth, at the bottom of a barrow which was opened near Dorchester. He had been buried with some coins of the Emperor Hadrian, and it is probable, therefore, that the seeds were sixteen or seventeen hundred years old." It is likewise recorded that some bulbs which were taken from the hand of a mummy found in one of the pyramids, and which had been immured between two and three thousand years, produced unknown plants when sowed in one of our botanic gardens. Even some animals may be reduced to a perfect state of inactivity, and their respiratory and circulatory functions may cease, but on again being called into the active state, these functions resume their wonted energy. Thus fishes after being frozen have manifested renewed animation when their natural element again became fluid; and in an interesting paper in the Dublin Journal of Medical Science, "On Latent Heat and Vital Crystallization," Dr. Greaves mentions a remarkable instance of "long *suspended animation* or latent life." Dr. Macbride, of Dublin, having one day opened a chest in his museum, for the purpose of *washing in warm water* snail shells it contained, was called away for a time, and on his return found the animals creeping about on the sides of the vessel: these shells had certainly been in the collection nearly forty years.

In man, however, and in the higher orders of animals, a total suspension of respiration for a short period is fatal. In animals which hybernate there is a great diminution, but never a total suspension of vital action; in the hamster the pulse usually beats at the rate of one hundred and fifty per minute; but it is reduced to fifteen in the torpid condition. Marmots in a state of health and activity perform about five hundred respirations in an hour; but in the torpid state these occur only about fourteen times during the same period, and are executed at intervals of four or five minutes of absolute rest, and without any considerable enlargement of the chest. The disuse of the locomotive powers obviously renders unnecessary those changes which are essential to the maintenance of their active condition; and the organic functions, therefore, need do no more than preserve the integrity of their structures [1].

There are some few well-authenticated instances of recovery from suspended animation after the respiratory and circulatory functions had ceased for an unusually long period. It is recorded in the reports of the Humane Society that a lady who died in Herefordshire was restored to life after interment by a thief who attempted to steal a valuable ring from her finger. The case of Margaret Dickson, who was executed at Edinburgh in 1727, is amongst the best-accredited instances of recovery from suspended animation produced by hanging. The remarkable case of Colonel Townsend has been frequently referred to in order to show the influence of the mind on the action of the heart, though the power which he possessed over it was evidently affected by changes produced in respiration. It is said that a few days before his death he could expire when he pleased, and by an effort he could come to life again! Before making the experiment on the day of his death his pulse was distinct, though small and thready, and his heart had the usual beating. He composed himself, and lay on his back in a still posture for some time. His pulse sank gradually, till at last it could not be felt by the nicest touch; not the least motion could be felt in the heart, *nor the least soil of breath perceived on a bright mirror held to his mouth;* not the least sign of life could be perceived. He continued thus for half an hour; the motion of the heart was then observed gradually to return, and he recovered again, executed some business, and died the same evening [1]! All these cases must be regarded as exceptions to the general law, and as depending upon causes which are probably beyond the reach of human investigation. They are, however, sufficient to guard us against pronouncing any person irrecoverably dead before indications of decomposition have occurred; and they also hold out inducements to persevere in our measures for restoring a person apparently dead under circumstances the most disheartening.

ORGANS OF RESPIRATION.

The fundamental part of the organs of respiration in animals is a membrane, situated in such a manner that the circulating nutritious fluid may be in contact with one of its surfaces and the atmospheric air with the other; so that by this approximation those chemical changes may be effected which are the object of the function. This, the most simple form of respiratory organ, presents many varieties, and receives many accessary parts, as we ascend in our examination of it in the higher classes; all of which varieties and additions are subservient to the vital manifestations the being is destined to exhibit, and the respiratory medium which it inhabits. In the lowest animals the skin is the only respiratory organ; in many this membrane is prolonged in the form of respiratory lamellæ and tufts. In the higher aquatic animals the respiratory apparatus assumes the form of gills, which are disposed in fringed laminæ, and attached at the posterior and lateral parts of the mouth to four or five bony or cartilaginous arches analogous to ribs. The heart is so related to these organs that all the blood enters them before being sent to the system at large; and by the connexion of the gills to the mouth streams of water containing air are constantly being propelled over their surface. In bony fishes the gills are protected by a valvular covering, called the operculum, which allows the water, after it has served the purposes of respiration, to escape at its posterior free margin. If one of these animals be secured to a line, and its head drawn *with* the stream, the opercula acting as valves will prevent the entrance of water in the retrograde direction to the gills; and death in this case, being produced by asphyxia, will much sooner occur than when the animal is killed by exhaustion, or by what has been called "playing it."

In reptiles, birds, and mammalia, the respiratory membrane is formed into hollow vesicular sacs, situated in the thorax, and communicating, by means of a trachea and larynx, with the pharynx, and through it with the nasal and oral cavities. The hollow respiratory vesicles in reptiles present many varieties. In some they are in the form of elongated sacs, as in serpents; in others, as the crocodile, they are subdivided, to a great degree of minuteness, by internal partitions. In birds and mammalia, whose vital manifestations are more dependent on the energy of the respiratory process, the air-cells are much more minutely subdivided, and the amount of surface over which the blood is exposed to the influence of the atmosphere is, in consequence, much greater than in reptiles. The lungs of birds, moreover, communicate with membranous sacs situated in the chest and abdomen, which again are prolonged into most of their hollow bones; so that in those birds whose bones are thus permeated by air, though the trachea be tied, the animal will still continue to respire by an opening made in the humerus.

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[1] Carpenter's Principles of General and Comparative Physiology.

[1] Wardrop on the Nature and Treatment of the Diseases of the Heart, 1837.

In man the organs of respiration consist of the lungs, which communicate with the atmospheric air by the trachea. Besides the subdivisions of this air-tube, they are also composed of the ramifications of the pulmonary artery, which carry to them, from the right heart, the venous or "black blood," to be brought into approximation with the atmospheric air; and of the ramifications of the pulmonary veins which return the arterialized blood from them to the left heart. In common with the other parts of the body, the lungs receive blood-vessels for their own support, nerves, lymphatics, and connecting cellular tissue. They are likewise covered with a serous envelope (the pleura), which is reflected from them on the inner aspect of the cavity in which they are contained (the thorax).

The thorax consists of active and passive agents of locomotion, by which the respiratory movements are effected, and its capacity alternately enlarged and diminished. The passive agents are the dorsal vertebræ, the ribs and sternum, and their connecting cartilages and ligaments. The active agents are the respiratory muscles destined for the elevation and depression of the ribs and sternum; a perfect muscular diaphragm, separating the thorax from the abdomen; the abdominal, and the sphincter, and the levatores ani muscles.

The lungs, although the sole agents for carrying out the essential chemical process of respiration, are so dependent on the respiratory cavity in which they are placed, that if its movements be suspended, the atmospheric air is no longer transmitted to the air-cells. Mayow not inaptly compared the respiratory organs to a pair of bellows, containing an empty bladder, the neck of which, by being adapted to that of the bellows, should admit air on drawing its sides asunder. But although this is the case as regards the lungs and thorax in the act of inspiration, the former following the latter in its movements, yet, in the act of expiration, the lungs themselves, by their elastic property, perform a part in the process. On the other hand, the respiratory muscles, for the due performance of their part in respiration, require a direct communication with the cerebro-spinal axis, and this is effected by the system of respiratory nerves.

In addition to a special apparatus for respiration, in most, if not in all animals, the skin also performs the part of a respiratory organ. After the discovery of the production of carbonic acid by the lungs, enquiries were instituted to ascertain whether the same occurrence did not take place at the surface of the body; the only difference between the approximation of the air and blood in the lungs and in the skin being the different thickness of the membrane by which they are separated. The experiments of Millet, Lavoisier, Jurine, Cruikshank, Abernethy, Ellis, Mackenzie, &c., go to prove that when air has been kept in contact with the skin, carbonic acid is generated; whilst Priestly, Klapp, and Gordon were unable to detect, in their experiments, the slightest change. Whether cutaneous respiration takes place or not in the human subject, the "vivifying influence" of the atmospheric air on the skin in the recovery of persons asphyxiated, is admitted on all hands, and will be again referred to in alluding to Edwards's enquiries.

CAUSES OF ASPHYXIA.

From the review just taken of the object of respiration, and of the organs by which the function is effected in man, it is obvious that asphyxia may be induced in a variety of ways, all of which, however, may be reduced to two general heads; 1st, causes which affect, directly or indirectly, the respiratory apparatus itself; and 2nd, causes which affect the air, so as to render it unfit when respired to carry out the essential chemical object of respiration.

In the first place, the mechanism of the thorax in relation to the bones and cartilages which enter into its formation, may be so interfered with as to impede or totally suspend its movements; the respiratory muscles destined to produce those movements being at the same time in a condition, as regards their integrity and their connexion with the cerebro-spinal axis, fitted to do so. Examples of suspending the actions of the thorax in this manner are furnished us by the modes of punishment some nations occasionally adopt towards their prisoners, by burying them up to the neck in earth firmly pressed around them. In these cases the pressure of the surrounding earth upon the thoracic parietes being greater than the respiratory muscles can overcome, the motions of the chest are suspended, the atmospheric air no longer enters the lungs, and asphyxia takes place. A black, from the fine form of his chest and well-marked muscles, had been selected as an academic model. It was wished to obtain a cast of his body; but this being attempted at one operation, and in one entire piece, as soon as the plaster began to set he felt on a sudden deprived of the power of respiration, and, to add to his misfortune, was cut off from the means of expressing his distress. His situation, however, was fortunately perceived just in time to save his life, by breaking his bonds and releasing him from the extreme peril in which they had placed him[1].

Secondly, the muscles of respiration may be paralyzed by their connexion with the cerebro-spinal axis being severed, as occurs when the spinal chord is divided or compressed above the attachment with it of the respiratory nerves. Or the muscles may be so injured by extensive wounds or disease as to incapacitate them from performing their actions.

Thirdly, the respiratory movements may be interfered with, and the lungs compressed, in consequence of collections of fluids, such as serum, pus, &c., taking place between the pleural envelopes of the lungs and thorax. (Vide Empyema, Hydrothorax.)

Fourthly, the lungs, thorax, and respiratory muscles may be uninterfered with; but from causes which produce obliteration of the respiratory tube either by their acting of themselves, a strictly mechanical part, or by their presence producing spasm of the glottis, the access of air to the lungs may be prevented. Amongst the causes which induce asphyxia in this way may be enumerated all kinds of compression which operate externally upon the air-tube, such as strangulation, compression from tumours in the neck, or from foreign bodies impacted in the œsophagus; all foreign bodies received into its interior, and which fill its cavity; the effects of inflammation, as œdema of the glottis, the false membrane of croup or of chronic laryngitis, abscess of the glottis, fungous growths, submersion and the presence of non-respirable gases, or other causes which produce spasm of the glottis.

Fifthly, another class of causes may affect the ultimate ramifications of the bronchia, and interfere mechanically with the chemical end of respiration, by preventing the access of the inspired air to the blood, viz., effusions of fluid into the air-cells, the result of disease, or of division of the pneumo-gastric nerves.

The second class of causes which induce asphyxia by affecting the atmospheric air, consists of a too rarefied condition of this fluid, or the presence in it of certain gases. In both these cases the quantity of oxygen is not in due proportion in the respired medium, and the essential chemical object of respiration is therefore unattained.

If an animal be placed under the receiver of an air-pump, and the air be exhausted, or rather rarefied, it soon perishes; and if, during the performance of the experiment, air be re-admitted, it shortly revives. When an experiment of this kind is performed quickly, so as speedily to deprive the animal of the necessary supply of oxygen, death is speedily induced by asphyxia; but if it be slowly performed, or if the animal itself be allowed to respire the air it is confined in, it soon furnishes, in addition to the exhaustion of oxygen, a positively deleterious agent to the due performance of respiration, carbonic acid.

It is difficult to suppose a case of asphyxia occurring to man merely from an extremely rarefied condition of the atmosphere. It is even doubtful if the strange symptoms which travellers have experienced on reaching very high elevations are to be attributed to this cause, "producing a diminished pressure on the body," or to "an insufficient supply of oxygen for respiration." Boyle noticed the effects produced from ascending high mountains, and ascribed them to the rarefaction of the air. According to Haller, the peculiar sensations are to be attributed to excessive fatigue or exhaustion, rather than to any thing specifically depending upon the state of the air; and this opinion he supports from his own experience in his expeditions among the Alps, from the fact of individuals permanently residing in many parts of Switzerland at very considerable elevations without experiencing any inconvenience, and from effects of an analogous kind never having been noticed with respect to the different species of animals that are found in these regions. The account given by Saussure of the sensations he experienced at a very high elevation, and which he attributed to diminished pressure of the atmosphere upon the body, is not in accordance with that which other travellers have given us. "Respiration becomes laborious and panting, the pulse is quickened, and there is felt an universal uneasiness, joined to excessive weakness, and hæmorrhages come on[1]." Mr. Moorcroft informs us that when he was at the village of Niti, his breathing was quickened, and that he was obliged to *stop* frequently in consequence of the increased action of the heart; his breathing was often oppressed while he was lying down, and especially just before falling asleep. (Asiatic Researches.) The difficulty of breathing was also felt by Captain Webb when he visited Niti; and he adds, that horses are liable to it as well as men. (Quart. Journ.) Lieut. Gerard, who has ascended the Himalaya mountains to elevations of from fifteen to nineteen thousand feet, mentions that he suffered excessive debility and severe headache. (Geol. Trans.) Dr. Govan, who crossed the Himalayas at an elevation of considerably more than fifteen thousand feet, felt nothing peculiar in his respiration or other functions, nor was any of a train of forty natives who accompanied him in any way affected. (Brewster's Journal of Science.) Mr. Caldcleugh also, at an elevation of between twelve and thirteen thousand feet, seems to have experienced nothing more than what might reasonably be ascribed to fatigue; nor did any thing particular occur to his guides and attendants[2].

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[1] Roget, in Cyclopædia of Practical Medicine.

[1] Saussure, Voyage au Mont-Blanc. Richerand's Physiology, by Copland.

[2] Travels in South America. Bostock's Physiology.

"Some travellers who have ascended very high mountains have suffered much from rarity of the atmosphere near their summits. They have been unable to walk more than a few yards without stopping to take breath, and feeling extreme fatigue. This breathlessness has sometimes been accompanied by hæmorrhage from the lungs, sudden exhaustion of the muscular power, and fainting. These alarming symptoms are produced by the want of a sufficient supply of oxygen to the lungs, whilst at the same time the pressure of the atmosphere on the capillary vessels is diminished." *(Kay, on Asphyxia.)*

When such symptoms as those experienced by Saussure and others occur, they are much more likely to arise from excessive fatigue operating on a body unaccustomed to it, and admit of explanation on the principles of the musculo-cardiac and pulmo-cardiac functions[1]. In reaching those elevated situations the muscles are constantly and unusually exercised, and the quantity of arterial and venous blood within the cavities of the heart is, in consequence, increased, and hence "the pulse becomes quickened." The pulmo-cardiac function, by which the lungs regulate the supply of blood to the heart, so as to prevent congestion within the heart's cavities, is also more energetically called upon; and hence "the respiration becomes laborious and panting." In the balloon ascents which took place last year at the Vauxhall Gardens, individuals reached elevations greater than any already mentioned, without experiencing the least inconvenience; but the ascents to Mont-Blanc, &c., were accomplished by great muscular efforts, that in the balloon by none.

The gases which may be respired, and which cause asphyxia by their presence excluding the necessary supply of oxygen, are hydrogen and nitrogen, being of themselves otherwise uninjurious. The gases which are incapable of being respired in their pure state, and which asphyxiate by producing spasm of the glottis, are sulphurous acid gas, muriatic acid gas, nitrous acid gas, nitric oxide, ammoniacal gas, and chlorine. When these gases, however, are much diluted they may be respired; but they produce inflammation of the fauces and air-passages, or destroy life by acting on the texture of the lungs. Carbonic acid gas being the constant source of fatal accidents will be considered when treating of the varieties of asphyxia. Physiologists are not quite agreed as to its mode of action; some supposing it to be a positive poison, and others, simply an asphyxiating gas. The poisoning gases, such as sulphuretted hydrogen, carburetted hydrogen, &c., produce none of the symptoms of asphyxia. They act as poisons, and are received into the system in the same manner as the vapours of arsenic or hydrocyanic acid, when respired.

There are other gases also which are capable of being respired, but which do not asphyxiate, such as pure oxygen, and nitrous oxide. These, when they destroy life, kill by excitement, and consequently do not fall under our consideration at present.

GENERAL PHENOMENA OF ASPHYXIA.

When respiration is completely arrested for even a very short time, alarming symptoms supervene, and the effects are so speedily fatal, that it is difficult to note, with any degree of accuracy, their order of succession. The general phenomena, moreover, vary according as the quantity of oxygen in the respired medium is diminished, or is totally withdrawn. Some differences are also observed according to the means by which the supply is cut off.

In all cases of asphyxia certain general symptoms present themselves to us, and certain general appearances are revealed by the post-mortem examinations of bodies which have suffered death in this way.

When the access of oxygen is in any way prevented, the first effect perceived is an intense feeling of distress referred to the lungs; this is accompanied by a great desire to breathe, and by convulsive efforts of all the inspiratory muscles to expand the chest. This sensation becomes more and more insupportable; the animal gasps and makes use of all its efforts to gain a supply of atmospheric air, and the entire frame becomes agitated. These symptoms continue but for a short period before they are accompanied by vertigo and cerebral oppression, quickly followed by a torpor, which deprives the sufferer of all consciousness. Irregular and involuntary convulsive movements are exhibited in all the muscles; the face, and particularly the lips and eyelids, become livid and swollen; the eyes are suffused, and the surface generally becomes more dusky than the natural hue; the pulse is rapidly weakened, and soon ceases; the heart continues for a time feebly to propel the last scanty tide of black blood into the larger arteries; in a few moments its movements consist only of irregular contractions, until, at length, its action totally ceases, and all circulation is arrested. If asphyxia be induced slowly, the sufferings just enumerated are more protracted, and are accompanied with dizziness, singing in the ears, and confused vision.

Post-mortem appearances.—When the body is examined after death, its external surface exhibits a general lividity, from the imperfectly oxidized condition of the blood which is contained in the capillary vessels of the skin. The appearance of the countenance presents much variety; in some cases the eyes are distended and prominent, the pupils are dilated, and the features present an expression indicative of pain; whilst, in others, the features are calm and placid, and no swollen appearance of any part is presented. These differences of appearance exhibited in the countenances of individuals who have died from asphyxia induced by opposite causes, will account for some writers supposing the description which is given by Shakspeare of the frightful physiognomy of the Duke Humphrey as physiologically correct, and of others, of its being merely poetically so :

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[1] Wardrop on Diseases of the Heart. Lib. cit.

> "But see! his face is black, and full of blood;
> His eye-balls farther out than when he lived,
> Staring full ghastly like a strangled man;
> His hair upreared; his nostrils stretched with struggling;
> His hands abroad displayed, as one that grasped
> And tugged for life, and was by strength subdued."

The most remarkable appearances presented in the interior of the body are the following : there is a great accumulation of blood in the lungs, and these organs are sometimes so distended, that they forcibly protrude through the incisions made in the thorax for the purpose of exposing them ; the colour of the lungs is dark brown. On opening the trachea its mucous membrane is found injected with dark blood, and the intensity of the injection is greater as we trace the membrane towards the minute ramifications of the bronchia. The heart presents the coronary vein and its radicles distended with dark blood, as also its right auricle and ventricle, and the ascending and descending venæ cavæ, whilst the pulmonary veins, and the left auricle and ventricle, contain but a very small quantity of this fluid ; the latter cavities are in general found contracted. The viscera are congested with dark venous blood which escapes from them on being cut into, in consequence of its fluidity. The mucous membrane of the alimentary passages is also injected, and the larger papillæ, particularly those at the root of the tongue, are prominent. The sinuses and vessels of the brain are gorged with venous blood, and the cerebral substance, on being sliced, exhibits more than usually numerous dark red dots : sometimes there is an effusion of serum into the ventricles.

These appearances within the head, as well as those described of the countenance, will present more or less variety according to the method by which the asphyxia was induced, and to the length and violence of the struggle before total death occurred.

THEORY OF ASPHYXIA.

Previously to the discovery of the compound nature of the atmosphere, and of the changes produced in the blood by respiration, the several phenomena of asphyxia were accounted for on principles purely mechanical. The respiratory movements ceasing, it was supposed that the pulmonic circulation was arrested in consequence of the lungs themselves presenting an obstacle to the transmission of the blood through them ; in short, that the lungs, being no longer distended by the entrance of the atmospheric air, their air-cells became collapsed, their capillary vessels congested, and no blood being transmitted to the left heart, the systemic circulation was thus put a stop to. This theory, supported by Harvey and Haller, maintained its ground until 1788, when Goodwyn published his celebrated treatise, "On the Connexion of Life with Respiration," in which he refuted the opinion of Harvey and Haller, that in asphyxiated animals a mechanical impediment was offered by the lungs to the transmission of blood, and showed, that after air was once admitted into these organs, it could never again be sufficiently expelled to produce their supposed collapse, and that the quantity which remained after the fullest expiration was amply sufficient to distend the air-cells, and allow a free circulation of the blood in the vessels of their parietes. He thus overturned the theory of mechanical obstruction, and established another, which held its sway until the time of Bichat. Recognizing the importance of a supply of arterial blood for the due maintenance of the circulation, and seeing that when respiration was suspended the venous blood sent to the lungs was transmitted, unaltered in its qualities, to the left heart, Goodwyn supposed that this blood ceased to stimulate its cavities ; and in consequence of the left auricle and ventricle not being excited by their natural stimulant, arterial blood, they ceased to perform their wonted contractions, and thus the circulation was *here* primarily arrested. The theory of Goodwyn, as well as of those physiologists who went before him, was grappled with by the master mind of Bichat, and in its turn completely overthrown. Bichat showed, by a series of able experiments performed with his accustomed accuracy, that when an animal is asphyxiated, the venous blood is transmitted from the lungs into the left heart ; but that, instead of its not stimulating this organ, it had the very contrary effect, and was vigorously propelled by the left ventricle into the arteries, and thence into every tissue of the body. He demonstrated this in the following manner. Having adapted a tube, with a stop-cock, to the trachea of a dog, and having divided an artery, he closed the stop-cock, and thus prevented the further entrance of air to the lungs. At first the blood issued from the divided artery in a full stream, and was of a bright arterial colour ; but as the oxygen of the contained air in the lungs became exhausted, it gradually lost its arterial hue, acquiring a darker colour until it resembled venous blood : the blood after this continued for some time to be thrown out with its ordinary force, until, at length, the jet became smaller and weaker, and finally ceased. "I have seen," says Bichat, "a quantity of black blood discharged in this way, more than sufficient to kill the creature from hæmorrhage, were it not already dead in consequence of its asphyxiated condition." By this and other experiments Bichat showed that when the trachea of an animal was stopped so as completely to exclude the air, the venous blood continued to be sent in quantity and with force through the arteries for a time sufficient for it to permeate all the tissues of the organs. The theory of death by asphyxia, which was raised by Bichat on the foundation of these experiments, continued to be generally received as correct, until, by the later investigations of Dr. Williams, of Liverpool, and Dr. Kay, it was overthrown. Bichat held that the presence of black or venous blood in the organs was incompatible with the performance of their respective functions, and that especially the irritability of the brain and muscles soon perished under its poisonous influence. He injected into the carotid artery of a dog venous blood, and found that the creature appeared immediately to be agitated, breathed quickly, and seemed to be in a state of suffocation, similar to that of asphyxia. Its animal life became entirely extinct; the heart, however, continued to beat, and the circulation to go on for half an hour afterwards; at the end of which time the organic life ceased also. The same result followed when the blood taken from the arteries of an asphyxiated animal was injected into the carotid artery of another. From these experiments Bichat inferred that it was the presence of venous blood in the brain which produced the insensibility that so speedily supervenes in asphyxia, and that the suspension of the functions of all the organs connected with the cerebro-spinal axis necessarily followed this paralysis of the "cerebral powers." But in addition to this cause of the annihilation of the organs of animal life, in support of his doctrine he also contended, that the presence of the black blood in the muscles acted a prominent part; to prove which he injected the crural artery of an animal with the black blood taken from one of its veins, and shortly after the movements of the limb became enfeebled, and in other instances wholly paralyzed. In like manner the functions of the muscles of organic life became arrested, but at a later period than those of animal life; the heart continuing its action, poisoning, as it were, every organ. At length the function of the central member of the circulation itself becomes arrested; its coronary arteries become filled with black blood, and its structure penetrated with it; and suffering from the same cause in common with the other parts of the system, it dies. The main point of difference, then, between the theories of Goodwyn and Bichat lies in the former accounting for the arrest of the circulation, by supposing the action of the left heart to fail in consequence of not receiving arterial blood, its proper stimulus; and the latter contending that this arises from the heart itself, in common with the other organs, being penetrated by the deleterious black blood which eventually is fatal to its own action.

Two fatal objections to the theory of Bichat have been brought forward, and have been arrived at by actual experiment. The records of the Humane Society show that resuscitation, by the use of artificial respiration, has taken place after the individual operated upon had been submersed as long as fifteen minutes. And experiments performed on warm-blooded animals have likewise shown that resuscitation may be effected even after they have been immersed in water for seventeen minutes; and this at a time when the action of their heart must have ceased. If, then, the cessation of the heart's action arises, as Bichat supposes, from its structure being penetrated by venous blood sent to it by its coronary arteries, it is impossible to conceive how that action could be again restored by arterializing the blood of the capillary vessels of the lungs. Post-mortem examinations also of animals who have died from asphyxia, reveal that the cavities of the right heart and the lungs are distended with dark blood, whilst the cavities of the left heart are comparatively empty; a condition of parts which is evidently at variance with Bichat's views; for the left cavities should also be found distended, inasmuch as the dark blood continues to be sent to them, even to the heart's own destruction.

The researches of Drs. Williams, Kay, and Edwards, have fully proved that many of the views of Bichat have been too incautiously received; and Dr. Kay has embodied his views on the physiology, pathology, and treatment of asphyxia, in a volume specially devoted to that object. Dr. Kay views the organs of the body as being composed of a congeries of small blood-vessels, denominated, from their minuteness, capillaries. These vessels are possessed of peculiar powers, by which, in a healthy state, they only admit fluids of a certain quality, and exclude those which are incompatible with the functions of the part. They even resist the forcible introduction of other fluids, when injected with a syringe. In the lungs minute blood-vessels exist in an exquisitely delicate net-work; in these vessels the venous blood is exposed to the influence of atmospheric air; its qualities are changed; it loses its dark hue; and acquires a bright red colour; and hence Dr. Kay thinks it probable that the vessels in which the arterial blood circulates must differ, in their peculiar sensibilities, from those which propel the venous blood. He further conceives, that the laws generally observed to regulate the action of the small vessels in other structures, would be violated if the vessels which usually convey arterial blood were also able to convey with equal facility venous blood, in every state of its changes, until it acquires its darkest colour. When air is no longer inspired, a considerable quantity of this fluid remains in the ultimate bronchial subdivisions; and as long as this air contains a certain proportion of oxygen, the blood still undergoes its proper change in the pulmonary vessels, and the circulation proceeds with its ordinary activity; but as the proportion of oxygen diminishes, the blood ceases to acquire the bright vermillion colour, and becomes gradually darker, and the circulation progressively feebler and slower, "until when venous blood enters those vessels which formerly contained arterial blood only, this degenerated fluid is no longer able to excite their action, and the circulation stagnates in the structure of the lungs. The pulmonary veins then discharge their last meagre supply through the left auricle into the left ventricle, which propels its last and feeblest tide into the arteries, in which the circulation has, every moment, become more scanty, until the pulsation has gradually been extinguished." In support of his views Dr. Kay adduces one of Bichat's own experiments. "If a stop-cock be adapted to the trachea exposed and divided, and afterwards be shut, the blood becomes darker, and springs for some time with its usual force" from a divided artery; "but at length the jet becomes feebler; *re-admit the air*, the blood becomes almost immediately red, and its saltus rapidly increases." "In this experiment," observes Dr. Kay, "the exclusion of air is not continued so long as to produce a perfect abstraction of the oxygen remaining in the air-cells, when the stop-cock is closed; nor to extinguish the respiratory powers, the manifestation of which is resumed as soon as the stop-cock is re-opened. The blood, changed in colour, but not yet so much impaired in its qualities as to be unable to traverse the lungs, still circulates, and air is admitted at a moment when the danger of the occurrence of asphyxia is imminent; but when the respiratory powers and the organic functions are still supported by a blood partially oxygenated."

But in addition to the experiment of Bichat referred to, Dr. Kay performed others in further corroboration of his theory. He asphyxiated animals (rabbits and hares) by tying the trachea, and then opened a large artery, as the external iliac artery or the aorta. At the end of the second minute from the commencement of the experiment, when the external iliac artery was divided, a considerable quantity of dark blood flowed; but at the third minute it had almost ceased to escape. The heart continued to contract vigorously, and very small quantities of dark blood were observed to collect slowly every twenty seconds at the extremity of the artery; and although at the end of five minutes all flow of blood entirely ceased, the left heart continued to contract spontaneously for a very considerable period longer. When the aorta was divided no blood flowed from it after three minutes and a half, but the heart continued vigorous the usual period.

From these experiments Dr. Kay concludes that when the conversion of venous into arterial blood is prevented by excluding the atmospheric air, the blood gradually ceases to circulate in the capillary vessels of the lungs, in consequence of its being so changed as to fail in exciting the action of the vessels of arterial blood; the cavities of the left heart consequently receive a smaller quantity of blood, which is expelled for a time vigorously into the arteries. The ventricle, meanwhile, diminishes in size as the quantity of blood supplied becomes less, until, at length, although spontaneous contractions still occur in its fibres, no blood issues from a divided artery, and the ventricle, by contraction, has obliterated its cavity. After this, blood slowly accumulates in the auricle from the large vessels of the lungs, and its contractility continues for a very considerable period. In opposition, then, to the theory of Bichat and of Goodwyn, Kay argues with Harvey and Haller, in supposing the circulation in asphyxia to be primarily arrested in the lungs; but he does not suppose, with them, that this occurs from a mere collapse of the air-cells, or from a reflection of the vessels of the lungs on themselves offering a mechanical impediment to its transmission, but in consequence of the degenerated venous blood being insufficient to excite those pulmonary capillary vessels, whose natural stimulant is arterial blood.

In our account of Bichat's theory we have seen that he considered the presence of "black or venous blood in the organs to be incompatible with the performance of their respective functions, and that especially the irritability of the brain and muscles soon perished under its poisonous influence." Dr. Kay, however, conceives that dark blood from the left heart has no positively noxious influence on the muscles, but that its presence supports their contractile power for a considerable period. To prove this he secured three rabbits, and opened the abdomen of each; he tied the aorta of one above the renal arteries, and also the left common iliac close to the aorta. In eight minutes he opened the vena cava of the second, and the blood which immediately flowed he injected into the aorta of the first, and found the contractility of both extremities to be equally vigorous. At the fourteenth minute the degree of contractility having been ascertained by the insertion of needles attached to the wires of a galvanic battery, he injected another quantity of blood, and he found no difference in the contractility of the muscles in the two extremities. He then injected, in the course of thirty minutes, venous blood obtained from the cava of the third rabbit, and at each interval between the injections the wires were equally applied to the muscles of both extremities, and their contractility gradually and equally declined in each, as in experiments in which the artery is simply tied. Anxious, however, to compare the effect in the muscles, and with the blood of the same animal, *cæteris paribus*, he performed the following experiment:—The trachea of a rabbit was laid bare, a ligature was passed beneath it, and one also beneath the abdominal aorta, above the superior mesenteric artery. The aorta and trachea were tied nearly at the same moment; the muscles continued equally vigorous for some time on the application of the wires of the battery; they then equally and gradually decreased in strength, and in one hour ceased, contracting to the stimulus at the same time; the muscle of the upper extremity appearing, towards the close of the experiment, to be somewhat stronger. From these and other experiments Dr. Kay infers, that dark blood from the left heart has no positively noxious influence on the muscles, and that its presence in the voluntary muscles supports their contractile power for a considerable period. (*Kay*, 182.)

The effect of venous blood on the brain and nervous system has also been made the subject of inquiry by Dr. Kay, and various experiments which he has performed incline him to question even this part of Bichat's doctrine. He found that venous blood from one rabbit could be injected slowly and cautiously, so as to avoid all injury of the cerebral matter, into the carotid arteries of another, without causing more than muscular debility and lassitude; and from this he concludes that venous blood is only a weaker stimulus to the brain than arterial, and that the functions of this organ cease in asphyxia, because the circulation being arrested in the lungs, the diminished quantity sent to the brain is insufficient for its functions.

The general conclusion, then, which Dr. Kay deduces from all his investigations are, *First*, that the circulation is arrested after respiration ceases, because, from the exclusion of oxygen, and the consequent non-arterialization of the blood, the minute pulmonary vessels, which usually convey arterial blood, are then incapable of conveying venous blood, which therefore stagnates in the lungs. *Secondly*, that the arrest of the circulation is sudden when the lungs are entirely deprived of air, and that blood ceases to flow from them into the left cavities of the heart, even in the smallest quantities, in about three minutes and a half. *Thirdly*, that even supposing a great quantity of venous blood was transmitted through the lungs, it would not impair their contractility; but, on the contrary, it is even capable of supporting this power for a certain period. *Fourthly*, that venous blood does not possess any noxious quality, by which the organic functions of these tissues can be destroyed, but is simply a less nutritious and less stimulating fluid than arterial blood; and *lastly*, that the functions of the muscular fibre cease in asphyxia, because the circulation, and consequently the supply of the fluid which is necessary to life, is arrested in the lungs.

Of the different theories just enumerated, that proposed by Dr. Kay has received the most general assent of physiologists; except in that portion of it which relates to the cause of the stagnation of the blood in the venous capillaries of the lungs.

In the natural condition of the lungs, the circulation is carried on in those organs as in other parts of the body by arteries and veins; but here the arteries convey to them the venous blood, delivered by the right heart, and the same blood after being arterialized, is carried by the veins to the left heart. The venous blood in the lungs has been looked upon in consequence, as the natural stimulant to the capillary ramifications of the pulmonary artery, and the arterial blood as the natural stimulant to the capillary ramifications of the pulmonary veins.

We have seen that Dr. Kay thinks it probable, that the vessels in which the arterial blood circulates, must differ in their peculiar sensibilities from those which propel the venous blood, and that when venous blood enters those vessels which formerly conveyed arterial blood only, this degenerated fluid is no longer able to excite their action, and the circulation stagnates in the structure of the lungs.

But we very much question how far this explanation of the cause why the non-transmission of the venous blood through the capillaries of the pulmonary veins is correct; particularly when it is remembered, that after respiration has been arrested, the right heart continues so long to send with force the blood to the lungs. And, moreover, Dr. Kay himself agrees not merely with Bichat, in opposition to Goodwyn, that venous blood stimulates the left heart; but in opposition to Bichat's own theory, has shown by experiment, that it is capable of exciting instead of destroying the contractility of the muscles; and if cautiously and slowly injected through the carotids, of even stimulating the brain, though in a weaker degree than arterial blood.

This then being the case, as regards the action of venous blood in other organs of the body, it is a fair presumption, that in the lungs its presence is a sufficient stimulus to those capillaries, which in the natural process of respiration convey arterial blood; and if so, some other cause to account for the stagnation of the blood in these vessels must be looked for, besides the degeneration of this fluid rendering it an insufficient stimulus to the capillary ramifications of the pulmonary veins.

On this question Dr. Alison, whose opinion on all questions in physiology is deserving of much respect, observes, "the stimulus to the circulation which is given by the arterialization of the blood, which we have found to act chiefly in the capillaries of the lungs, is of the nature of an *attraction* of the venous blood, towards the part where it is to undergo this change, and towards the arterial blood in advance of it in the vessels; not of the nature of an increased contraction of the vessels themselves; and that it is in consequence of the failure of this *auxiliary power* in the circulation, that the stagnation of the blood in the lungs in asphyxia, and the extinction of the organic life, are effected."

This theory Dr. Alison arrives at, from a consideration of the powers which move the blood and other organized fluids in living animals, independently of any contractions of moving solids, such as the flow of blood to the mucous membrane of the stomach and bowels during digestion, to the uterus during gestation, and to any part of the body during inflammation. All which movements of the fluids, to a certain degree, are caused to be directed towards the part, where the power of digestion, &c. resides, by any stimulus given to such act of nutrition or secretion, although applied at the extremity of the capillaries, producing "an effect on the circulation which, as Sir C. Bell expresses it, is *retrograde along the branches* of the arteries :"—from the analogous movements of the fluids of vegetables which are offered on the application of heat, or other stimuli, to one of their branches or roots, in the absence of any evidence, to show the existence either of a structure or of a contractile power in the vessels or cells, through which the fluids pass, capable of giving them a determinate direction towards the parts which are thus stimulated :—from the fact, that the conversion of venous blood into arterial, which takes place in the lungs, is accompanied with an increase of fibrin in the latter, and also an increased tendency to coagulation, "which implies such an increase of an attraction of aggregation in the particles of the fibrin, as may be held to be strictly vital ;" and that, on the contrary, a change from arterial to venous blood is accompanied with a separation of the globules of the latter, its whole bulk appearing somewhat increased ; and also from the derivation of blood in all directions, which takes place towards an opening, when made in a vessel of a living animal.

Dr. Alison, moreover, insists, that we have no distinct evidence of the existence of coats, still less of irritable coats, in the minute capillaries of the lungs, and that the only vital power of contraction, which experiments authorize us to ascribe to any arteries, is a power of permanent or tonic contraction on their contents, which, when called into action, lasts for some time, and must impede the flow of fluids through them ; that the only powers arteries possess over their contents, according to Majendie and other eminent physiologists, is simply one of contraction, so as to lessen or retard their flow, and one of relaxation, so as to give them a free passage ; and that, conformably with these views, Wedemeyer found stimulating liquids when injected into the arteries of a living animal, were much longer in making their way into the veins than mild ones [1].

The difference then, on the question under our present discussion, between the theory of Dr. Kay and of Dr. Alison, is simply this. Dr. Kay supposes, when an animal is asphyxiated, the arrest of the circulation in the capillary ramifications of the pulmonary arteries and veins, arises from *a cause* which is to be referred to the capillaries themselves ; these vessels failing in their action, from the want of their proper stimulus, or in Dr. Kay's own words, "the minute pulmonary vessels which usually convey arterial blood are incapable of conveying venous blood, which therefore stagnates in the lungs [2]." Whilst Dr. Alison, for the reasons already so largely quoted, attributes *the cause* of the stagnation of blood, not to "the nature of an increased contraction of the vessels themselves," but to a failure of that "auxiliary power" in the pulmonic circulation, which is "of the nature of an *attraction* of the venous blood towards the part where it is to undergo the change into arterial blood ;" the power itself inducing this *attraction* being the process of arterialization ; to the accomplishing of which process, the admission of pure air to the lungs is essential, but which admission in asphyxia is prevented.

It too often happens in physiology as in other sciences, that when any new theory is propounded, those which preceded it are either altogether lost sight of, or are merely mentioned as matters of history.

The theory of digestion, which at one time was solely a concoction, at another a fermentation—a nervous function—a chemical solution—a vital principle, and so on—is an example of what has happened in this way ; not to mention the history of animal heat, absorption, the seat of vision, and, indeed, every observed function of the human body. All these "have had their day," as the common expression goes ; and when the imagination, at first raised and dazzled by the new doctrine, subsides, and judgment resumes her seat, the older opinions, when again examined, are found, if not perfect, at all events, of some assistance in helping to explain the subject under enquiry, or in accounting for many of its phenomena.

The older physiologists, including Harvey and Haller, as we have already seen, looked upon the stagnation of blood in the capillaries of the lungs in asphyxia, to be caused by the suspension of the movements of the thorax. Goodwyn showed, that after these movements ceased, dark blood was for a short time sent to the left heart. Bichat, in rejecting Goodwyn's own theory of the non-exciting power of this blood to the ventricle, although he sneers at the idea of angles of vessels, and collapsed air-cells offering any impediment to the passage of the blood through the lungs ; yet details an experiment admirably calculated to show the instantaneous effect of the respiratory movements in facilitating the passage of this fluid.

If a stop-cock be adapted to the trachea, and an artery opened, the blood will blacken, and continue for some time to be thrown out with its ordinary force ; but at last the jet will gradually grow weaker. If after this the air be admitted, the blood will almost *immediately* become red, and its jet visibly *augmented;* and Bichat further observes, that this *impetuosity* depends on the *movements of respiration,* to which the animal is obliged on the admission of air. "Besides, the influence of a series of full respirations may be manifested without dividing the trachea ; open the carotid artery, and hurry the respiration of the animal by tormenting it (for pain will constantly have this effect), and the jet will be visibly increased." These observations, although made to account for "why the *heart* ceases to act when the chemical functions of the lungs are interrupted," bear much more strongly in demonstrating the effects of the respiratory *movements* on the pulmonary circulation. And it is strange that Bichat should have added, that in the ordinary state of health, "a series of strong expirations will not be found to quicken the pulse."

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[1] Cyclopædia of Anatomy and Physiology.

[2] Kay on Asphyxia, p. 181.

In considering all these different theories, it appears to us that much more is to be attributed to the effects of the mechanical movements of the thorax, in carrying out the pulmonary circulation, than seems willing to be conceded.

When the fœtus makes its first inspiration, the expansion of the thorax carries with it the subservient lungs, and two new currents are immediately established in these organs; one a current of air by the trachea, the other a current of blood by the pulmonary arteries; and which latter current is diverted towards the respiratory organs by their expansion, otherwise it would move as before through the ductus arteriosus. This first respiratory movement acts strictly a mechanical part in bringing the two currents towards each other, and such being the case, the auxiliary power of Dr. Alison does not in this case exist, because the flow of blood to the air-cells is accomplished contemporaneously with the flow of atmospheric air.

In after life, the regular succession of the involuntary respiratory movements is admitted, on all sides, to be most remarkable and difficult of explanation. "The increase of the blood's impulse by expiration is in many persons so great, that the pulse at the radial artery becomes imperceptible when inspiration is long continued, and the breath held. This is the case with myself, and it in some measure explains the fable, of persons possessing the power of altering the actions of their heart at will[1]."

The condition of the blood in the collapsed stage of malignant cholera, its dark character, and its extreme thickness from the loss of its serum, must offer great difficulty to its transmission through the lungs; yet we know this to be accomplished, as is evidenced by the feeble pulse which is detected in the larger arteries; and as the chemical changes of respiration are here nearly, if not wholly suspended, the transmission of the blood must be entirely dependent on the respiratory movements, which are performed with a gasping effort. When powerful emetics have been administered in this condition of the system, and when they have succeeded in producing vomiting, we have repeatedly observed the pulse return for a short time in the smaller arteries; which stimulus to the circulation was doubtless effected by the respiratory movements which accompany this action.

Before we enter upon the consideration of the general treatment of asphyxia, it is necessary to notice briefly the interesting researches of Dr. Edwards[2].

The first inquiry of Dr. Edwards we shall notice, is that which relates to the comparative influence of air and water upon the nervous and muscular systems,—a question, as Dr. Kay justly remarks, of grave importance, when considered as affecting the treatment of asphyxia. The singular power possessed by reptiles, of living a considerable time after the excision of the heart, afforded Dr. Edwards a means by which the respective influence of air and water could be appreciated. By the removal of the heart, the circulation of the blood, and, as a necessary consequence, respiration, are annihilated. A part of the blood escapes; and that portion which remains may be regarded as a constituent part of the organs. The nervous and muscular systems alone are left, and these are inseparably connected. If, after having cut out the hearts of reptiles, taking care to remove also the bulb of the aorta, an equal number be placed in air, and in water deprived of air, the difference in the duration of life, if any difference exist under these two circumstances, will indicate the respective influence of these media on the nervous and muscular systems, independently of that which it may exert on the circulation and respiration.

Dr. Edwards removed the heart and bulb of the aorta from four salamanders; he exposed two of these to the air, and immersed two others in water of the same temperature, which had been deprived of air by boiling. In about four or five hours the salamanders in water appeared dead; but that life still existed was rendered evident, when they were moved or pinched. One died in eight hours, the other in nine. Those in air, however, lived from twenty-four to twenty-six hours. These experiments he repeated with the same precautions, upon six other salamanders, and obtained similar results; hence he inferred, that air, in comparison with water, has a superior vivifying influence upon the system of these animals, independent of its action by means of circulation and respiration. Similar experiments were also performed on frogs, six of which were placed in air, and six in water deprived of air. Those in water lived two hours, those in air three; and their activity, which continued to be considerable after the excision of the heart, decreased much more rapidly in the water than in the air, and stimulation produced much less effect.

What confirms, however, in the most striking manner, the vivifying effect of air, and the deleterious effect of water on the nervous system, is the following. If a frog, deprived of its heart and immersed in water, be drawn out and exposed to the air, at the moment when all signs of life have disappeared, it immediately begins to recover. If it again be plunged in water, all appearance of life instantly ceases; and it may thus be made several times alternately to lose and recover its motion and sensibility.

In order to determine the influence of the circulation of venous blood on the nervous system, frogs, whose hearts had been removed, and an equal number of these animals uninjured, were placed in vessels containing water deprived of air. The frogs in which the action of the heart and the circulation continued, always survived the others a considerable period, and sometimes above twenty-four hours. Similar results were obtained with toads and salamanders. Hence Dr. Edwards concludes, that the circulation, even of venous blood, is favourable to the action of the nervous and muscular systems, though incapable of maintaining life beyond a very limited period.

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[1] Müller's Physiology, by Baly.

[2] Influence des agens physiques sur la vie.

Lest it might be presumed that the water, in which the animals were immersed in these latter experiments, exerted a deleterious influence on their nervous and muscular systems, preventing the venous blood from prolonging life so much as it would have done in a less noxious medium, Dr. Edwards performed the following experiment.

He strangled six frogs, by tying very tightly, with a packthread round the neck, a piece of bladder fitted very closely to the head, so as to exclude the air; the ligature itself being sufficiently tight to effect this. At first the frogs were paralysed; but they afterwards to a great degree recovered, and lived from one to five days; while the same number in water were dead in ten or twelve hours. The same experiment on salamanders was attended with similar results, and one of these animals lived twelve days, until its head became gangrenous from the effects of the ligature.

The marked difference also which exists in the duration of life in animals strangled, and in those immersed in water, shows, that in the former, life is supported many days without any other action of the air, than that which may be exerted on the nervous system, or on the blood through the medium of the skin. To demonstrate the influence of the air on the blood, through the medium of the skin, frogs strangled with bladder and a ligature, as in the preceding experiments, were placed in receivers containing atmospheric air. They were removed an hour or two after, and a sensible quantity of carbonic acid was detected in the air of the vessels.

Dr. Edwards' next inquiry was, how far the facts just detailed may be modified by various circumstances; and further experiments warranted him in concluding, that as the *temperature* of the water, in which the animals are immersed, is reduced, so will the duration of life be prolonged. Thus when the temperature of the Seine water was cooled by means of ice to 50° Fahrenheit, it was found, that of two frogs immersed in it, one lived five hours fifty minutes, and the other six hours fifteen minutes. When the water was reduced to 32° Fahrenheit, eight frogs were introduced into it, and they lived from six hours seven minutes to eight hours eighteen minutes. When, instead of cooling the water, its temperature was raised to 72° Fahrenheit, that of the air being 68° Fahrenheit, the frogs only lived from one hour ten minutes to thirty-five minutes; when it was raised to 90° Fahrenheit, they died in from thirty-two minutes to twelve minutes; and when it was raised to 108° Fahrenheit, they scarcely lived a few seconds, and in no instance exceeded two minutes. It is worthy of remark, that the degree of heat at which frogs cannot survive immersion in water is about the natural temperature of warm-blooded animals.

The influence of temperature on fishes, he also found to resemble that on the Batrachians. If a bleak (*cyprinus alburnus*) be put into a vessel with a large mouth, containing five ounces and a half of aerated water at 68° Fahrenheit in summer, it dies within a few hours; but when the temperature is lowered to 50° or 53° Fahrenheit, and kept at that point, the animals lives until its secretions are so abundant as to corrupt the water.

The general result to be arrived at from these facts is, that, notwithstanding the different conditions in which the animals are placed, the more the temperature is raised beyond certain limits, the greater is the degree of the influence of the air required for the support of their life.

Dr. Edwards' experiments on warm-blooded animals are also full of interest, and bear even more directly on our present inquiry.

In consequence of the circulation being more rapid, and the nutritive function more active in young animals, it has been a general opinion that their temperature is much higher than in adults; but the contrary is the fact. A thermometer being placed in the axilla, and the bulb applied so as to be on all sides in contact with the animal, it was ascertained that the temperature of some new-born puppies whilst in the act of sucking was nearly equal to that of the mother, being about a degree or two lower; this difference not being constant, and being observable among adults also, it may be altogether disregarded.

When, however, at a temperature between 50° and 68° Fahrenheit, a new-born puppy was removed, and kept an hour or two from its mother, its temperature fell considerably, and continued falling, until, in the course of three or four hours, it stopped a very few degrees above that of the surrounding air. The same phenomenon took place with kittens and rabbits.

The effect of these experiments was ascertained not to be occasioned by the want of food, for the temperature began to fall as soon as the separation from the mother took place, and the diminution was not in the least retarded by furnishing the young animal with milk from time to time. Neither can it be attributed to the want of an artificial covering, which could only retard and not prevent the lowering of the temperature; and in some animals well covered with hair at birth, exposure, though more slowly, produces the same effect.

It appears, then, the young animal produces less heat in a given time than the adult; and as it advances in life, that it gradually acquires a greater power of producing heat, until at the end of a fortnight it enjoys this faculty equally with its parent.

The young of the mammalia, however, are to be distinguished into two classes, in relation to the production of animal heat. Some are born, as it were, cold-blooded: others warm-blooded. Corresponding with this difference, a distinction is deducible from the state of the eyes. Some are born with their eyes closed, others with the eyes open. The temperature of the former rises successively, and at the end of a fortnight (which is the period when the eyes open) it is nearly equal to that of adults. Thus the state of the eyes, though having no immediate connection with the production of heat, may yet coincide with an internal structure influencing that function, and certainly furnishes signs which serve to indicate a remarkable change in this respect, since, at the period of the opening of their eyes, all young mammalia have nearlythe same temperature as adults.

The young of birds are also to be divided into two classes. Some when hatched can eat and run, and are only covered with a tolerably thick down, and this class can maintain a moderately elevated temperature, if exposed to the air in a favourable season. Another class is born without down or feathers, is incapable of providing for itself, and is in a similar condition in relation to the production of heat with cold-blooded animals. Young birds, however, require a degree of heat equal to that of adults of the same species, and which neither the mild warmth of spring nor the strong heat of summer can supply. The temperature of this class is preserved by the shelter of their nests, their mutual contact, and the assiduous care of their parents, who impart the warmth of their own bodies to them during all the time that is not occupied in obtaining food; but when separated from each other, and exposed to the atmosphere, they rapidly cool down to within one or two degrees of the temperature of the air.

It is from within alone that animal heat can originate, however outward coverings may contribute to retard its dissipation. Accordingly an adult sparrow stripped of its feathers, cutting them so as completely to expose the skin, preserved the temperature which it had before the experiment, being 36° Fahrenheit above that of the atmosphere, which was at 64°; whilst, on the contrary, young birds of the same species, taken from their nest, where they had a suitable degree of warmth, and which the feathers they had begun to acquire, tended to preserve, cooled down to within one or two degrees of the external air.

From these and similar facts, it appears that the power of producing heat in warm-blooded animals is at its minimum at birth, and increases uniformly until adult age.

The duration of life, when animals are deprived of air, extends to every age, in the opinion of Dr. Edwards, and should serve as a strong reason for not rashly applying a high external temperature, for the restoration of persons from a state of suspended animation.

From further experiments of Legallois and Edwards, there appears to be an intimate relation between heat and respiration in both cold-blooded and warm-blooded animals. The dividing of the eighth pair of nerves produces, along with other phenomena, a considerable diminution in the opening of the glottis, so that in puppies recently born, or one or two days old, so little air enters the lungs, that when the experiment is made in ordinary circumstances, the animal perishes as quickly as if it were entirely deprived of air; it lives about half an hour. But if the same operation be performed upon puppies of the same age benumbed with cold, they will live a whole day. In the first case the small quantity of air is insufficient to counteract the effect of the heat, but in the other it is sufficient to prolong life considerably. (*Edwards, Lib. cit.*)

GENERAL TREATMENT OF ASPHYXIA.

Having seen that Asphyxia may be induced in a variety of ways, the first object of the practitioner must evidently be directed to the removal of the individual from the continued influence of the exciting cause, and the second to the re-establishment of the respiratory functions of the circulation, and of the functions of the brain and nervous system.

Temperature. — The researches of Dr. Edwards, which we have just quoted, are calculated to throw great light on the importance of attending to the degree of temperature to which the asphyxiated should be subjected, as well as the quantity and kind of covering which should be placed upon the body before attempting to make use of other restoratory measures.

The practical inferences applicable to adult age, and particularly to man, which he deduces from his experiments, are the following:— A person is asphyxiated by an excessive quantity of carbonic acid, in the air which he breathes; the beating of the pulse is no longer sensible, the respiratory movements are not seen, his temperature however is still elevated. How should we act to recal life? Although the action of the respiratory organs is no longer visible, all communication with the air is not cut off. The air is in contact with the skin, upon which it exerts a vivifying influence; it is also in contact with the lungs, in which it is renewed by the agitation which is constantly taking place in the atmosphere, and by the heat of the body which rarefies it. The heart continues to beat, and maintains a certain degree of circulation, although not perceptible by the pulse. The temperature of the body is too high to allow the feeble respiration to produce upon the system all the effect of which it is susceptible. The temperature must then be reduced, the patient must be withdrawn from the deleterious atmosphere, stripped of his clothes, that the air may have a more extended action upon his skin, exposed to the cold, although it be winter, and cold water thrown upon his face until the respiratory movements reappear. This is precisely the treatment adopted in practice to revive an individual in a state of asphyxia. If, instead of cold, continued warmth were to be applied, it would be one of the most effectual means of extinguishing life. This consequence, like the former, is confirmed by experience.

In sudden faintings, when the pulse is weak or imperceptible, the action of the respiratory organs diminished, and sensation and voluntary motion suspended, persons the most ignorant of medicine are aware that means of refrigeration must be employed, such as exposure to air, ventilation, sprinkling with cold water. The efficacy of this plan of treatment is explained on the principle before laid down.

Likewise in violent attacks of asthma, when the extent of respiration is so reduced that the patient experiences suffocation, he courts the cold even in the most severe weather; he opens the windows, breathes a frosty air, and finds himself relieved.

Admitting then the correctness of Dr. Edwards' views, of which there can be little doubt, the directions which have been given by the Royal Humane Society for the recovery of persons apparently dead, are liable to objections; first, in regard to the temperature recommended, and, secondly, to the re-clothing and otherwise enveloping the body. On these points the following directions have been given :—“ While some assistants are engaged with artificial respiration, others, we have already hinted, should be employed in communicating continued heat to the body. Dry warm blankets, bags of warm grains, or sand bladders, or bottles of hot water, or hot bricks, or hot blankets, wrung out of hot water, are amongst the means most easily obtained. The body may be placed before a fire, or in the sunshine, if strong at the time. Whatever may be the means employed, the restoration of warmth should always be arduously pursued. Should the accident happen in the neighbourhood of a steam-engine, brew-house, bake-house, or any fabric where warm water may be easily procured, it would be of great importance to place the body in a warm bath, moderated to a degree of heat not exceeding one hundred degrees. The warmth most promising of success is that of a heated bed or blankets. Bottles of hot water should be laid at the bottoms of the feet, to the joints of the knees, and under the arm-pits; and a warming-pan, moderately heated, or hot bricks wrapped in cloths, should be passed over the body, and particularly in the direction of the spine. A large bladder should be applied, filled with hot water, and inclosed in flannel, to the region of the stomach and heart. The natural and kindly warmth of a healthy person, lying by the side of the body, has been found in some cases of adults, and particularly of children, very efficacious; but the warm bath, where it can be procured, is preferable to all other means of communicating heat.”—*Royal Humane Society's Report*, 1833, p. 100.

Were the directions here recommended to be implicitly obeyed, the enfeebled vital actions would be in danger of extinction, and the “ apparent death” would soon become real. The temperature of the apartment in which the body is laid, should in general not be higher than 75° or 80°; and Dr. Edwards even recommends in some cases that it should be lower than this. The advantage to be derived from exposing the surface of the body to the vivifying influence of the air is altogether lost sight of, when the body is recommended to be “ re-clothed,” “ to be wrapt in blankets wrung out with hot water,” or to be immersed in a “ warm bath.” Where heat is demanded, its application is therefore preferable in the radiant form, and when *conducted* heat is called for, it should be so partial in its application, as to interfere but little with the exposure of the surface to the “ vivifying influence” of the air. The employment of heat in the radiant form also gives us the opportunity of applying friction and other excitants to the body, and does not interfere with our endeavours to restore life by artificial respiration.

The body should therefore be placed before the fire, or in the sunshine, and bottles of warm water, or warm bricks, applied to limited portions of the cutaneous surface, such as the soles of the feet, or the arm-pits. A proper temperature also may be applied to the spine and back by means of the tin mattrasses filled with warm water, such as were recently used during the prevalence of cholera, in several of the hospitals. By these proceedings the influence of the air on the skin, in rousing the action of the capillaries, and imparting oxygen to the blood, is uninterfered with, whilst friction, the application of stimuli, and, above all, artificial respiration, can be advantageously resorted to.

We have been thus particular in detailing the researches of Dr. Edwards and their application to the human being when in a state of asphyxia, in consequence of the directions of the Humane Society being sanctioned by the authority of others who have treated of this subject. And no matter how great the caution exercised in avoiding the too sudden application of heat, the circumstances of the case must be very peculiar indeed which should warrant us in raising it beyond what we have already recommended, much less to the height of “ 98° or 100°”.

Artificial Respiration.—Simultaneously with the employment of a well-regulated temperature, artificial respiration should be resorted to. When we consider that the natural process of respiration is carried on by the alternate dilatation and contraction of the thorax, and the admission of pure atmospheric air to the lungs, it is obvious that, in a state of asphyxia, the operation by which we attempt to restore respiration resolves itself into two processes. The first, by which we imitate the natural movements of the thorax, and the second, by which we convey air to the lungs, the latter process being called insufflation. Without the contemporaneous use of these two processes our measures generally prove abortive ; and if insufflation alone be attempted the consequences may even be highly dangerous. There are many cases on record where animation was restored by the simple application of pressure to the chest and abdomen, by which a portion of the carbonised air was expelled, and on the pressure being removed, a portion of atmospheric air entered the lungs by the natural elasticity of the chest allowing it to recover its former dimensions ; whilst, on the contrary, when insufflation was resorted to, without reference to the movements of the thorax, the most unhappy consequences have been the result. In accordance with the views of Goodwyn, who supposed the contractile power of the left heart to be destroyed, in consequence of the *venous blood* which was sent to it not being its proper stimulus, insufflation was injudiciously recommended, and for a time universally adopted ; and as much as one hundred cubic inches of atmospheric air was advised to be introduced into the lungs at each inflation, with a force sufficient to overcome any impediment that might offer to its reaching the air-cells. The fatal results which must have followed an operation of this kind are obvious, and Leroy, whose instrument for insufflation we shall presently have to speak of, has satisfactorily shown, that without requisite caution, the most pernicious results follow. He ascertained that brisk sufflation of air into the trachea killed rabbits, foxes, goats, sheep, and other animals, even when the force employed was that of an expiration from the human lungs. To some other animals, however, such as the dog, the operation was not so injurious. Air, briskly introduced into the lungs, generally ruptures some portion of their tissue, and, issuing into the cavity of the pleura, occasions their collapse, and thus fatally interferes with the process of respiration. In order to prove this, air was injected through an opening in the intercostal spaces of an animal, and its immediate death ensued. On opening the bodies of animals killed by brisk insufflation, the diaphragm was found to be protruded into the abdomen, forming an elastic salient tumor in that cavity, and the lung was seen contracted into a small volume within the chest. Leroy and Majendie also revived some animals by making a puncture in the parietes of the chest immediately after brisk sufflation had been practised, and thus permitting the effused air to escape from the cavity of the pleura. Occasionally bubbles of air were introduced into the sanguiferous system by some rupture of the pulmonary vessels, and ecchymosis and effusion of air beneath the pleura were generally observed ; and both Leroy and Majendie report that they frequently occasioned a rupture of the pulmonary tissue, and a consequent escape of air between the layers of the pleura, by forcible inflation in the human subject.

The directions given regarding this operation must therefore be received with some caution. This discovery reveals a sad retrospect of absolute evil, produced by the want of caution with which these means have been applied for the recovery of persons apparently dead, and show how presumptuous has been the interference of the most benevolent. The dangers are so great, that it is evidently not sufficient to diffuse a knowledge of them through the community, and to depend on the caution which this acquaintance with them may inspire ; but it is desirable to have an apparatus which may be more safely entrusted to those who are distinguished by eminent professional sagacity and prudence [1].

Before attempting the resuscitative process, the following preparatory measures should be adopted. The body, stripped of its clothing, should be laid on a table, or on a board, supported by chairs of a convenient height : the head, shoulders, and chest, should be somewhat elevated, and, if necessary, the mouth and nostrils cleansed of mucus, which can be effected by means of a handkerchief wound round the finger.

As free a circulation of fresh air as possible should be permitted, and with this view the doors and windows of the apartment should be left open, and no more persons than are absolutely necessary allowed in the room. The body should be exposed to a proper warmth before a fire, at a temperature of from 65° to 70° Fahrenheit.

Bottles, containing warm water, or warm bricks, if the surrounding air be too cold, may be applied to the legs and arms. No heat however should be applied above 80° Fahrenheit, as a higher degree of temperature exhausts the vital energies. The natural and kindly warmth of a healthy person lying by the side of the body has been found, particularly in children, very efficacious. The warm bath should never be made use of, as water not only exerts an injurious influence on the body, but interferes with the exposure of it to the vivifying influence of the atmosphere.

These precautions being taken, pressure should now be made upon the chest and abdomen, by which the deteriorated air will be in part dislodged from the lungs ; when, upon the pressure being withdrawn, fresh air will be received into these organs, in consequence of the capacity of the thorax being restored, in virtue of its own elasticity, as well as by the descent of the abdominal viscera. By applying the flame of a candle to the mouth and nostrils, or the down of a feather, it can be ascertained that on each firm pressure of the body air is expelled from the lungs, and that upon the pressure being removed, air rushes in.

In conjunction with these attempts to imitate the natural respiratory movements, and in the absence of a proper instrument for the purpose, insufflation may be performed in the following manner. Having closed the mouth of the body and one of the nostrils, the operator should blow into the other, having previously by strong suction removed as far as possible the deteriorated air. This method of insufflation when practised, should be performed through the nostril, the natural appendage to the respiratory tube, in preference to the mouth.

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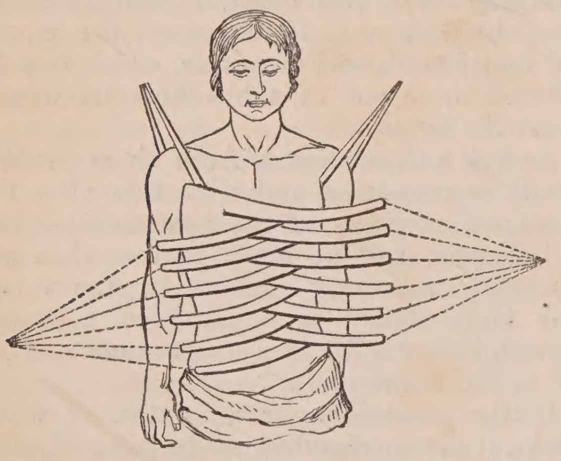
[1] Kay on Asphyxia, p. 228.

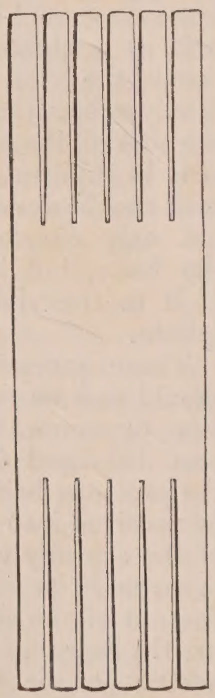
We have hitherto supposed a case where no apparatus was at hand for the performance of these two operations; it is now necessary for us to describe the several instruments which have been recommended, and the use of which have been sanctioned by experience. The bandage of Leroy has been particularly described by the Humane Society, and is admirably calculated to produce the alternate contraction and dilatation of the thorax (figs. 111 and 112).

Fig. 111.



This bandage may be formed in the following manner. A piece of strong flannel, a blanket, sheet, or any other kind of cloth most easily to be obtained at the moment should be selected. It should be six feet in length, and eighteen inches in breadth; six strips should be cut or torn lengthwise on each side, and each strip should be three inches broad and two feet long. The untorn portion of this bandage should be placed under the back of the body, extending from the arm-pits to the upper part of the thigh bones, and the strips brought together over the chest and belly, interlacing each other from the opposite sides, as the fingers are interlaced in grasping the hands: the strips thus arranged should be gathered into a bundle on each side, and upon being drawn, by two assistants in opposite directions, the edges of the bandage will be made to approach each other, and firm and equal pressure will thus be produced on the thorax and abdomen.

Fig. 112.



When the assistants have made the necessary degree of pressure, upon their relaxing the bandage the thorax will expand; and if at the same moment the head and shoulders of the body be elevated, the diaphragm will follow the abdominal viscera in their descent. By these proceedings the capacity of the thorax will be increased in all directions, and the atmospheric air be invited into the passive lungs which follow its movements. The use of this bandage, and the inflation of the lungs in the manner directed, may be safely entrusted to the hands of non-professional persons, but the application of other instruments which have been devised for the performance of artificial respiration, or even the use of the ordinary pair of bellows for this purpose, should be entrusted to the surgeon solely.

For the purpose of introducing a curved canula into the glottis, with a view of injecting air into the trachea and its ramifications, Leroy has invented an instrument, which, by depressing the tongue and elevating the epiglottis, greatly facilitates this operation.

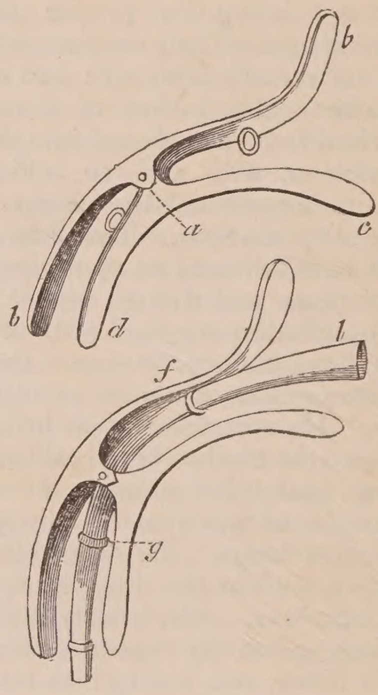


Fig. 113.

Fig. 114.

Figs. 113 and 114 represent Leroy's instrument; it is composed of two parts articulated at *a*, figure 113. The branch *b b* is fixed, the branch *c d* is moveable. When the extremity *c* is elevated towards *b*, the extremity *d* is depressed, and it is made to act on the base of the tongue so as to elevate the epiglottis. Fig. 114 represents the canula *l l* in its place in the instrument. It is attached to the fixed branch by a ring *f*, and at the other end it follows the motions of the other branch, to which it is attached by another ring *g*. The motion of this branch, at the same time that it depresses the base of the tongue and elevates the epiglottis, directs the canula to the opening of the larynx, and if it then be pushed forward it enters the glottis.

When the canula is thus introduced, the bellows provided with a graduated arc, indicating the quantity of air proper to be introduced at different ages, should be attached to the tube, and before commencing inflation, an effort should be made to remove by suction at the canula, any fluid that may be in the windpipe, such as water, mucus, or the deteriorated

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To Correspondents:—The Editor acknowledges the communications of Dr. Warren, Boston, U. S.; Mr. Dunn, of Scarborough; Mr. Alcock, of Stockton; Mr. Slee, of Middleborough; and Mr. Martin, of Calcutta. The interesting points to which they refer will be brought under the notice of the respective writers to whom these articles have been confided. Dr. Hays of Philadelphia is requested to accept the Editor's best thanks.

⁂ Circumstances have for a time interrupted its publication, and protracted the appearance of this Part; but the Editor is happy to be enabled to state that the cause of the delay has been entirely removed, and that in future the Parts will be published with punctuality at the periods already stated. He trusts also it will be found that the interval, which has elapsed since the publication of the third Part, has been profitably occupied in the improvement of the general plan and in securing the co-operation of additional Contributors of the most distinguished reputation.